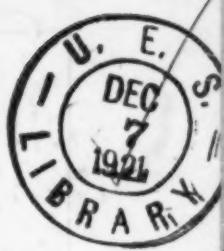


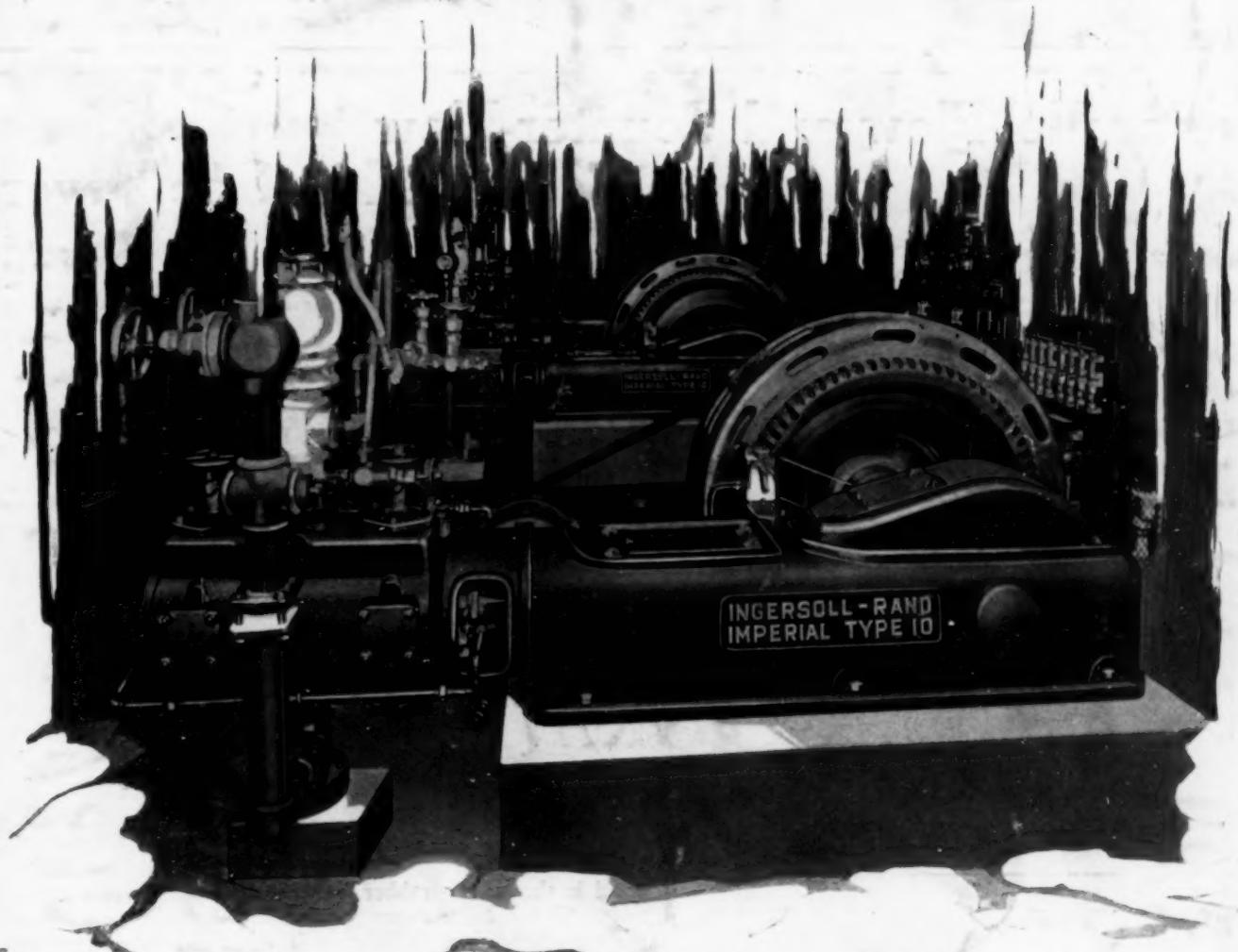
# CHEMICAL & METALLURGICAL ENGINEERING



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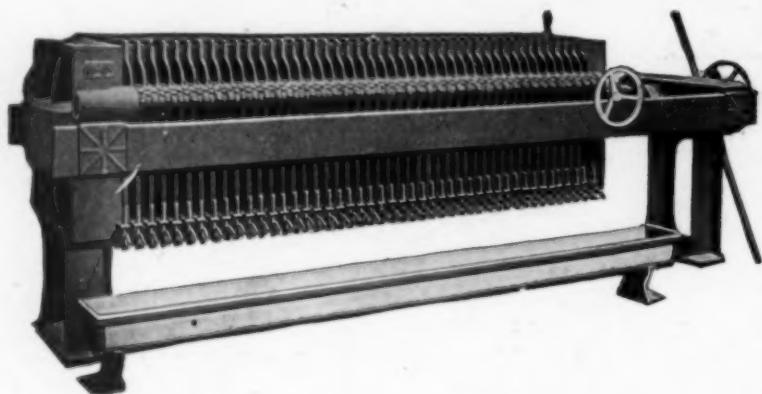


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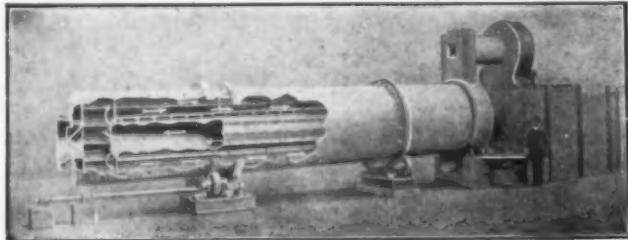
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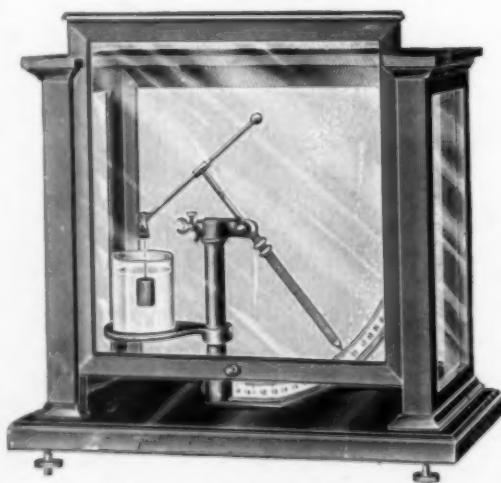
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Number 23

## Land Armaments And Business Recovery

BUSHING aside the academic and partisan contention that the United States should keep out of European affairs, we believe it is growing clear that we are no longer confronted with the problem of whether we should keep out or get in, but rather of how much deeper we must get in before we can fairly get out. Whether we like it or not and whether it conforms to sonorous platitudes glibly quoted, the fact remains that the economic welfare of the United States is inextricably bound up with that of Europe. Splendid isolation will avail us nothing in efforts to bring about the desired revival of business.

Let us see if we can clarify the situation in a few words. Admitting that foreign trade is not essential to some of our industries, nevertheless there are others of fundamental importance like mining and agriculture that will not revive until foreign trade in considerable volume is again possible. Certainly the restoration of international trade in something like pre-war volume is a prerequisite to world prosperity. But it is idle to talk of developing foreign trade when the financial systems of Europe are crashing about our heads and when there is no stable basis on which to frame tariffs for future business.

Obviously there must be some logical and basic place to begin the rehabilitation of the world's economic and financial systems. Europe is more stable socially and politically than at any time since the Armistice. It is only in finance that there has been continued degradation. Money has depreciated because of inflation through printed currency. Printing presses have been kept busy because national expenditures have exceeded national income. Fiscal budgets have been unbalanced. And the curious coincidence about the fiscal deficits of the countries of central Europe is that they correspond almost exactly with the cost of maintaining land armaments in those countries. Four or five million men are under arms, including the Rhine army of 350,000 men with its tremendous cost to Germany contributing to her recognized inability to meet the reparations.

Have we not here the crux of the situation? If European land armaments could be greatly reduced and limited, fiscal budgets would be more nearly balanced. Inflation could cease. Exchange could then be stabilized and commerce could be resumed on a basis that could be depended upon to last over night. If the cost of maintaining land armaments is breaking down the financial systems of Europe and if that breakdown is being reflected in decreased buying power and unstable business conditions throughout the world, wouldn't it be wise to take steps to reduce land armaments? And might not the United States call an international conference for the purpose of considering land disarmament in Europe in its relation to worldwide economic and financial conditions?

Taking our cue from the present conference on naval disarmament and problems of the Far East, which gives every reasonable expectation of a successful issue, we think that a second conference might profitably be called at an early date to deal specially with economic and financial matters and the limitation of land armaments. The two are intimately related. The hopeful influence of such a conference cannot be overestimated. The mere announcement of the Hughes plan at the opening of the present conference caused a rise in all European exchange that could have been produced otherwise only by the movement of large quantities of goods. It increased confidence in world recovery, which is so greatly needed now. The calling of a second conference on economic conditions would likewise react favorably on world business.

It has been suggested that the present conference might consider this problem, but we are inclined to believe that it should be differently constituted. In addition to political representatives, such a conference should comprise men representing the great business interests and activities of the respective countries. The problems before such a conference would be essentially business problems, and as such should receive the attention of the best business minds. Probably no decisive steps can or should be taken to convene a new conference until the present one has had a successful outcome. But the call should be made as early as possible so that its stimulating first-aid influence can help sustain business until permanent stabilizing measures can be adopted.

We feel that we are not wrong in advocating the appointment of representatives of business and industry, capital and labor to a conference on economics and finance. Recent history affords ample evidence to support the contention that business leaders have long seen what political leaders have been either unwilling or unable to see with regard to the trend of economic affairs. Certainly the best views of the situation in Europe that have been laid before business in this country have come from American business men and bankers who have studied conditions at first hand.

## Prevention of Tuberculosis A Means of Increasing Business

SINCE the prevention of waste has become one of the cardinal principles of increasing production, any known means of eliminating waste of man power is a matter of vital interest. Prevention of tuberculosis unquestionably means a conservation of the human element in production, when it is known that this disease is responsible for one-third of all the deaths which occur in this country among persons between the ages of fifteen and forty-five years. In other words, tuberculosis strikes down man and woman alike during the period of their productive years.

The nature of tuberculosis is well known today and

numerous carefully conducted studies have demonstrated that its existence depends to a great extent upon conditions in which men work. There are, naturally, some particularly bad features about certain trades. Chief among these are the so-called dusty occupations, for dust inflames the air passages of the lungs and makes these passages liable to the disease. Not all dusts are dangerous, however, for coal dust apparently has no bad effect. Coal miners are even less likely than others to have the disease, and only one-third as many cases of tuberculosis appear among the coal miners in Pennsylvania as among other persons.

Of the workers showing a high mortality for tuberculosis, there are, first, the grinders, then tool makers, printers, stone cutters, brass workers, garment workers and furriers and all classes who are exposed to mineral and metal dusts. On the other hand, boot and shoe makers and millers have a very low mortality rate for this disease. In mining and the related industries the death rate from tuberculosis, with the exception of coal miners, is higher than for other work. This is particularly true of certain mining industries, such as copper, silver and lead mining. The reason for this is apparent, for metal mining is attended in most cases by the inhalation of particularly hard, sharp, flinty particles that find their way into the lungs and set up an irritation which makes fertile soil for the growth of the tuberculosis germ. Significant in this connection is the fact that out of the 44,000,000 men and women workers in the United States nearly 4,000,000, or 9.06 per cent, are employed in dusty trade industries and occupations.

That it pays to prevent tuberculosis in industries is well demonstrated in the experience of such large concerns as the New York Telephone Co., Metropolitan Life Insurance Co., Sears Roebuck Co., the International Harvester Co. and many others. The actual dollars and cents saved to these concerns as a result of health work aimed against tuberculosis has demonstrated the value and soundness of their investments along this line. It not only pays to prevent tuberculosis directly in industries but it pays also to prevent tuberculosis in the general population, of which the workers and employers alike are a part.

There is abundant evidence that any community can purchase a reasonable degree of freedom from tuberculosis if it is willing to pay the price. This price is not excessive, probably not more than \$2 per capita per year, spread over a period of 10, 15 or 20 years. Proper community organization can control disease, the extent of the control depending upon the intensiveness of organization. The annual December sale of tuberculosis Christmas seals furnishes the funds. Hence every person who buys Christmas seals is helping in a fight to conserve human life and therefore to prevent a waste of man power in business.

It is obvious that every person whose life is prolonged by the prevention of tuberculosis means increased wealth to the manufacturer and merchant because of the added working capacity of the individual. Nor is prevention a far away and hazy mirage. The fact is that the National Tuberculosis Association and its 1,200 affiliated agencies are fighting a winning war against tuberculosis. In the 15 years since the association began its work the death rate from tuberculosis in this country has been reduced from 200 per 100,000 population to the present figure of 120 per 100,000 population. This has been estimated to mean a clear saving of 75,000 lives a year.

### New Propaganda For Old

A SPECIAL session of Congress has adjourned. Many of the legislators are at home, mending fences, and perhaps thereby getting clearer impressions of what their constituents think about it all. But they will immediately reassemble in regular session, and be engulfed in the whirl of politicians, lobbyists, patriots and well-meaning folk who clutter up the Capitol and increase the difficulty of doing the nation's business.

One of the important things yet to be done is to provide adequate protection for the chemical industry. It is not our present purpose to recount recent experiences proving that it is quite necessary for our country to have a well-developed chemical industry. That point is doubtless pretty well established. Nor is it desired to discuss various schemes which have been proposed, and all but enacted into law, for the fostering care of this essential industry. That ground has been covered at length many times. What we should like to emphasize is this—that whereas it is possible to present a convincing argument before congressional committees, and thus obtain a favorable report, it is and will be extremely difficult to get Congress as a whole to accept and act upon these reports. It naturally follows that success depends upon the ability to educate the Congressman hailing from the corn belt, who doesn't know much about chemistry except that a big bunch of nitrogen blew up recently in Germany, and the Senator living in a textile center who has been told that the American dye trust is a band of robbers.

We venture to express the opinion that friends of the industry would do well to emphasize the importance of chemistry to human progress and comfort, and to talk less about killing. Let's admit that chemistry has been introduced into warfare and we know very well that where science enters there it stays. We know, too, that with industry developed in organic chemistry, these factories are themselves arsenals of defense which cost the government nothing and can be quickly transformed to the production of the instruments of death and destruction.

But aren't we fed up on war and sick and tired of it? The minds of the civilized people of the whole world are against war. They have had more than enough! The gasp of incredulous joy which burst from every nation upon hearing Mr. HUGHES' disarmament proposals should entirely convince any but the stubbornest militarist that blood-curdling accounts of horribly dangerous poisons are no longer correct propaganda in support of the chemical industry.

Fortunately, machinery which can synthesize organic chemicals—like dyes, explosives, drugs, perfume and fabrics—are good for much else than for war. Otherwise, the chemical science and industry would not be worth saving, and we should be glad to help it along the path the battleship is taking. So, in abandoning the old arguments, there are new and cogent ones ready at hand which, instead of exciting fear and mistrust, light contentment and hope. A good anesthetic or a specific for so mild a disease as measles would eventually save the future part of the woe the Hohenzollerns loosed upon the past. Not one, but a hundred, such discoveries are to be made in the future. And where, pray, will these be found if not by most advanced chemical research? In fact, only through this and its sister science physics can the process of life and the causes of death be anything but mystery. Here is common ground to

approach the corn-planter and the cotton-spinner, the miner and the fisherman.

We believe in the chemical industry because it is founded on truth, and its intensive development will promote our nation's economic health as will no other. That industry must be preserved and fostered because it will help every American to *live*, to live with more ease, more comfort, more safety, more health and joy. We believe in chemistry, because chemistry is life.

### Speeding the Business Revival

EVEN in the chemical industry there is a widely prevalent feeling that "business is on the mend." This attitude on the part of our manufacturers augurs well for the future of business; it gives us a psychological advantage of real value. A year ago when trade began to fall from its post-war peaks, we started talking about business depression and hard times, we quit buying and very naturally business began to slump. In contrast with this pessimistic background, most of us at the present time are thinking in terms of business revival and are eagerly watching for signs of improvement and encouragement.

Obviously these signs will differ for the different industries and they will not carry the same significance to each of us. The iron and steel industry, for instance, has long held to the view that large-scale buying by the railroads was certain to herald the return of prosperity. This industry has recently had ample reason to be encouraged, for since the last week in October the railroads have been buying rails, locomotives, cars and other supplies on an increasingly heavy scale.

Most engineers regard new construction and the letting of building contracts as the most reliable index of business activity. It is heartening, therefore, to know that a building boom is sweeping the country. Contracts during October exceeded those in October, 1920, by 25 per cent and were only 10 per cent less than in the record month of September, 1921. One authority has reported the contracts for October to have reached \$222,500,000 and has pointed out that November's total promises to show a more striking increase. That the chemical and metallurgical industries are keeping pace with the building boom is shown by the following figures compiled from the Industrial Notes which appear weekly in this magazine:

			Total Cost	
	Oct.	Nov.	Oct.	Nov.
Projects planned...	34	43	\$11,338,000	\$26,353,000
Contracts awarded.	26	27	3,940,000	12,199,000

Construction on such a large scale means increased production of chemicals and a broadening market for chemical equipment, but, what is even more significant, it proves that chemical manufacturers are looking forward to the upward trend in business and are willing to make active preparations for it.

There is still another sign of encouragement which we are inclined to regard as the real proof that the wheels of industry are again in motion. In our news pages each week since Oct. 11 has been published an imposing list of industrial plants which have resumed operations or have materially increased their production. These give us incontrovertible evidence that manufacture is again under way and that the shut-down factories are gradually awakening from their period of lethargy. May the good work continue and may our weekly lists grow until they have included every plant in the chemical and metallurgical industries!

### College Degrees For the Credulous

OUR excellent French contemporary *Chimie et Industrie* of Paris contains the following advertisement in its issue No. 4, Vol. 6, October, 1921:

Promotion de doctorat (par correspondance).  
Université étrangère (U.S.A.) offic. reconnue.  
Ecrire avec curric. vitæ à Prof. Demole, Case Rhône 3373 Genève (Suisse).

They know better than that in France and they know better in Geneva. The acceptance of such an advertisement casts unfortunate reflections on all American university degrees. It belittles the academic honors lately bestowed on Field Marshal FOCH. We venture to state that there is no officially recognized university in the United States in which "Professor" DEMOLE of Geneva can arrange for doctorates in science or philosophy or letters or law, or in anything else, by correspondence.

It's curious how willing Europeans are to believe absurd things about the United States. To explain to credulous foreigners the customs of the country, the killings and shootings that make things interesting on the streets and to expound the unconventional ways of Indians and buffaloes constitute one of the few joys in life left to Americans. That sort of thing has become a habit with many of us, like killing sheep among dogs, because it is so easy. It is, however, an ancient sport. Sir JOHN MANDEVILLE was addicted to it back in the fourteenth century, as witness his description of the inhabitants of certain islands in his "Voyages and Travels."

And in another yle are foule men that have the lippes about the mouth so greate, that when they sleep in the soone they cover theyr face with the lippe. And in another yle lyttle men, as dwarfes, and have no mouth but a lyttle round hole & through that hole they eate their meate with a pype, & they have no tongue, & they speake not, but they blow and whistle, & so make signes to one another. In Ethiopie are such men as have but one foote, and they go so fast yt is a great marvaill, and that is a large foote, that the shadow thereof covereth ye body from son or rayne, when they lye upon theyr backes; and when theyr chilidren first be borne they loke like russet and when they waxe olde then they be all black.

The habit, it will be observed, is not even original with us Americans. But when foreigners imagine degree factories in the United States and proceed to fleece one another by selling false diplomas, it ceases to be innocent merriment. Thousands and thousands of young men and women come to our institutions of learning from all over the world, and they work hard for their degrees. They prize them highly. They stand for merit, just as French and Swiss and Italian and German degrees do. Of course, no one here can stop the precious DEMOLE from his misuse of foreign mails. But scientific and technological journals should not encourage the practice. The situation is very much as though we should publish an advertisement from somebody in Quebec offering to procure the decoration of the Legion of Honor for those who apply—and comply with his terms. It would be easy enough for him to fake up a diploma in French and to send a little red ribbon to his dupes—but it would not be ethical for us to help him. And we do not think it ethical for *Chimie et Industrie*, which is, generally speaking, an excellent paper, and for which we have a high regard, to permit DEMOLE to make use of its columns for his nefarious operations.

## Readers' Views and Comments

### Nitrogen in Carburized Steels

*To the Editor of Chemical & Metallurgical Engineering*

SIR:—In connection with the article appearing under the above title in CHEMICAL AND METALLURGICAL ENGINEERING, Nov. 9, 1921, page 867, it has just been called to our attention that no mention has been made of Fay's work in the same line, referred to in a note published in your journal in the issue of Feb. 16, 1921. The note referred to contains valuable analytical data having a very direct bearing in the subject under discussion in our paper, and promises later a full discussion of the entire subject, in which Dr. Fay has evidently been interested for some time. It is a matter of regret to the authors that such an important contribution should have been overlooked in the preparation of our paper.

W. E. RUDER.  
Schenectady, N. Y.

G. R. BROPHY.

### What Causes Slip to Halt?

*To the Editor of Chemical & Metallurgical Engineering*

SIR:—In studying the Slip Interference Theory of the Hardening of Metals as first published in CHEMICAL & METALLURGICAL ENGINEERING, June 15, 1921, by Zay Jeffries and R. S. Archer, and in critically reviewing the older theories as well as discussions which have appeared relative to the new theory, this writer is unable to find a satisfactory explanation of the stopping of slip.

In a later paper entitled "The Amorphous Metal Hypothesis," published in CHEMICAL & METALLURGICAL ENGINEERING, Oct. 12, 1921, Jeffries and Archer ask the question, "What causes slip to halt?" There seems to be no better reason known at present than that originally offered by Beilby. Quoting from the paper by Jeffries and Archer on "The Slip Interference Theory of the Hardening of Metals," we find the following as an explanation for the stopping of slip:

The amorphous metal theory of Beilby offers what appears to the present authors to be the only completely satisfactory explanation of this phenomenon. The rubbing together of the crystal fragments on the plane of slip is supposed to tear some of the surface atoms loose from their regular crystalline arrangement, thus forming a layer of amorphous metal. The friction generates heat rapidly, so that a high temperature is reached locally. This high local temperature softens the amorphous metal, which is essentially merely an undercooled liquid. With the softening of the amorphous metal layer the resistance to slip diminishes and there is less frictional heat developed. The high local temperature is then quickly dissipated by conduction to the surrounding metal, whereupon the amorphous metal hardens and offers a resistance to further slip which is greater than that on planes on which slip has not yet occurred.

At this point let us look into the amorphous metal theory as proposed some years ago by Beilby. After reading carefully the last paragraph above quoted, it seems that there is not a satisfactory explanation given for the stopping of slip. The last sentence in the above paragraph appears to be the weak point. If amorphous metal is formed on the cleavage plane by friction and if friction generates heat enough to soften materially this amorphous metal so that slip occurs rather easily for a time, then as cooling begins the viscosity of this

amorphous metal increases, its resistance to slip increases, the heat of friction likewise increases and the tendency will be for a certain viscosity to be obtained such that its resistance to slip will create enough heat to equal the heat dissipated by conduction.

If conduction gets ahead for a time and the temperature momentarily drops, then the viscosity increases, the resistance to slip increases, the rate of generation of frictional heat will increase and at once build up the temperature to a point where the viscosity is lowered and a balance is obtained between heat generated and heat conducted away from the source of generation. If this proceeds, we should expect ultimate failure to occur along the cleavage plane of first slip. This, however, is not the case and the writer will presently endeavor to explain why. I certainly cannot conceive of the heat of friction being conducted away from the amorphous cement "instantly," as Beilby's theory indicates.

The time consumed from the beginning to the end of slip on any particular plane must indeed be quite small. It seems reasonable that the time required for conducting away the generated heat would be a large percentage of the total time of slip, even though it is only necessary for a portion of the total heat to be removed from the place where it is generated. There is no license to use the term "instantaneously," as Beilby says it, when speaking in relative terms, since this leads to the inference that the time required for conducting the heat away will be very short, or negligible, in comparison to the total time of slip. It seems that something else must take place to retard the rate of slip, which in turn will retard the rate of heat generation and by so doing give the amorphous metal opportunity to "set."

The following explanation is offered to account for the stopping of slip. Referring the strength of metals to the atomic bonds that oppose stresses working toward the deformation of the metal, it will be agreed that the elastic limit is determined by the maximum number of atomic bonds that simultaneously oppose the force that first tends to cause deformation. No other atomic bonds will ever come into full action in opposing tensile stresses until the elastic limit has been exceeded. As soon as the elastic limit has been exceeded slip occurs on some cleavage plane (or planes) containing the least number of active atomic bonds per unit area. Following Beilby, I assume amorphous cement to be formed on this plane and heat to be generated in amount sufficient to permit slip to take place freely. Slipping cannot go on very far, though, without additional atomic bonds being brought into action to oppose the slip in a manner similar to the way that after a few fibers in a rope under stress have given way, additional ones begin to be stressed so that their resistance must be overcome. In fact, this is in keeping with the statement of Jeffries and Archer that "The strengthening of metals by cold work can only be due to some mechanism by which the interatomic bonds are brought more effectively into play so that more of them have to be broken simultaneously." As soon as this new set of atomic bonds is stressed and

must be overcome it is to be expected that the rate of slip on the plane on which it is progressing will materially slow down. When this happens the amorphous metal will have its opportunity to cool down and to set.

Or again, if one wishes to reject the theory of Beilby as impossible (as Jeffries and Archer have done on page 703 of *CHEMICAL & METALLURGICAL ENGINEERING*, Oct. 12, 1921), he still may offer the following explanation to account for the stopping of slip on one plane and the beginning on another. Reasoning as before, the plane which has the fewest active atomic bonds will be the one upon which slip first occurs. After slipping to a slightly new position, a great many more atomic bonds may be brought into action. May not these new bonds, when brought into action, make this plane more resistant to further slip than it was in the beginning and more resistant than other planes upon which slip has not yet occurred? As slipping proceeds it may happen and perhaps does, that as stronger and stronger planes are slipped the one upon which slip first occurred may by the process of elimination again become the weakest plane. It therefore may slip again until an additional set of atomic bonds is brought into action. One plane, then, is not limited to slipping just once during rupture, but may slip a number of times depending on the atomic arrangement. O. A. KNIGHT,

School of Mines, Associate Professor of Metallurgy.  
State College, Pa.

Prof. Knight has made it clear that without some interference, slip once started should continue at a rate of speed determined by the frictional resistance of amorphous metal and the heat conductivity of the surroundings. Is it not reasonable to suppose that slip stops because the forces which started it are momentarily released?

Stresses in a test-piece are ordinarily distributed irregularly. But suppose uniform distribution across a test-piece of fine grained metal. Even then some crystals will be so oriented that the load will throw a shear of maximum intensity along the crystalline plane offering lowest resistance. As the loading increases, the shearing strength of this crystal is passed and slip starts. But any actual movement suddenly disarranges all the neighbors. The slip once started speedily becomes "jammed," the stresses once resisted by the yielding crystal are thrown into adjoining particles of metal which safely bear them. Immediately the outside forces are released, slip stops, and any amorphous material generated immediately freezes into a very rigid and strong substance.

It may be objected that a test-piece may be formed of a single crystal, and this crystal will show much ductility under load, finally breaking in a highly contracted area. There is no chance for transfer of load to neighboring crystals. But could not the release of stress be due to the fact that inertia of the testing machine or imposed load prevents the stress immediately following the very rapid movement of the broken crystal? If this is true, the load is released momentarily, movement stops, and the amorphous material generated at the slipping plane solidifies.

Immediately after this solidification there should be an added stress due to impact, when the load catches up with the lengthened specimen. A ductile material should withstand this impact; a brittle crystal, on the other hand, would fail. Perhaps this distinguishes between these qualities.

EDITOR.

### Scientific Relief Suggested for Russian Chemists

To the Editor of *Chemical & Metallurgical Engineering*

SIR:—I read with great interest your editorial regarding the whereabouts of the famous Russian chemists and later your editorial on sending relief to them.

I have in hand the first issue of the Scientific-Technical Bulletin of the Supreme Council of National Economy, published by the Russian Government in Moscow in 1920. In this bulletin is given a review of many chemical publications, among which is one of Prof. Ipatieff's recent book, "A Course in Organic Chemistry," 416 pages, published in Petrograd in 1919. Furthermore, I have before me a recent Russian newspaper which gives the personnel and the work and achievements of the Russian Supreme Council of National Economy. This Council consists of eleven of Russia's foremost representative engineers and is the highest technical body engaged in working out the industrial program of Russia. Prof. Ipatieff is one of these eleven and the newspaper in question speaks very highly of his scientific contributions to the industrial reconstruction of Russia.

Your suggestion to send relief to the Russian chemists is indeed an excellent one and very practical. Perhaps the greatest contribution that American chemists and scientific men could at present make to stricken Russia is in the form of chemical and scientific literature, from which she has been shut off since the beginning of the great war.

May I suggest that you take the initiative and issue an appeal to American chemists and men of science, through the American Chemical Society, to send to Russia some scientific and chemical publications since the year 1914? No deed or act on the part of American chemists could be more noble or humanitarian than the execution of your suggestion. The Russians have expressed their appreciation and admiration for the American relief in the famine-stricken districts. Russia's scientific men will equally appreciate this scientific relief. History will, I have not the slightest doubt, prove this.

Such scientific contributions can be transmitted, for distribution among the higher institutions of learning, to the Scientific-Technical Department of the Commissariat for Education, Moscow; or it can be sent to the Society for Technical Aid to Russia, 110 West Fortieth St., New York City, for transmission to the above address in Russia.

I shall be glad to assist you in carrying out this plan. I have recently talked with Dr. Benjamin T. Brooks, who thought very highly of such relief to the Russian chemists.

New York City.

JOSEPH R. MINEVITCH.

**EDITOR'S NOTE:** We are glad to publish this letter emphasizing the importance of one phase of the relief program for Russian chemists outlined in an editorial in our Oct. 26 issue. The appeal should meet with a hearty response.

### Correction

The title of the article by Wilbert J. Huff, published on page 865 of our issue for Nov. 9, 1921, was misstated. It should read "Corrosion Beneath Oil Films, and the Protective Action of Certain Colloidal Solutions."

## British Chemical Industry

FROM OUR LONDON CORRESPONDENT

LONDON, Nov. 15, 1921.

AS FORESHADOWED in my previous notes, the violent fluctuations and great depreciation in the value of German currency have influenced markets to a considerable extent and the general uncertainty has retarded recovery. On the other hand, quotations from abroad are now generally given in sterling and this method of compensating for fluctuations has slightly stiffened quotations, though as regards fine chemicals there is not much prospect of alteration in prices at present.

### ON THE EVE OF IMPORTANT DEVELOPMENTS

It is notorious that new epoch-making British inventions have in the past been mainly developed abroad, but at the present time many new processes, to which a wealth of time and effort have been devoted, appear to be on the point of fruition. The barium process for the manufacture of cyanide is an example of close co-operation among the fuel expert, the expert on refractories and the highly trained chemical engineer. Calvert's process for the production of alcohol, referred to in my notes published on July 13, has now made further progress and it has been stated that with water gas at 15c. per thousand cubic feet, a production cost for power alcohol of 16c. per American gallon is in sight, while the capital outlay is relatively very low. It is understood that Calvert's process is now being tried out on an industrial scale and that important developments may be expected early next year. The idea of making alcohols from water gas is not new, but previous investigators appear never to have got further than the production of methane or ethylene, whereas Calvert obtains his product in one operation and of 50 per cent strength.

In this connection it is interesting to learn that Bury and Ollander's process for making alcohol from the ethylene in coke-oven gas is to be installed at two other plants, but it is considered to be unlikely that the cost of production will be less than 30c. per American gallon.

### PROGRESS IN SYNTHETIC AMMONIA

The progress foreshadowed in my last notes regarding the Claude process has been realized and it is understood that the first installation will be in Norway and that work is to commence immediately. The electrolytic method of hydrogen manufacture will be used, under which the cost of production of hydrogen is expected to work out at 80c. per thousand cubic feet. The Claude catalyst tubes are to be made of Vickers special nickel-chromium steel, which appears to be very similar in all its properties to the new Krupp steel "V2A," which was used successfully during the war for a variety of chemical plant, including centrifugal pumps for nitric acid. Claude's tubes are 7 ft. long and 4 in. internal diameter and it is understood that the French Government Commission's report will pronounce in Claude's favor and against the Haber process. It was thought that the Oppau works would not be rebuilt until the success or failure of Claude's process was known, but it is now known that the works are to be restored with all speed and production is to be expected at the beginning of next year. The cause of the explosion can almost certainly be ascribed to the blasting

of mixed fertilizer, and it seems indefensible, however often the use of explosives had failed to detonate the fertilizer mixture, to have invited disaster by the use of such methods. The function of an explosive has always been to explode and with a potential explosive mixture of this kind, the risk was great.

### BRITISH CHEMICAL ENGINEERS DISCUSS FORMATION OF AN INSTITUTION

The feeling that a qualifying body similar to the American Institute was necessary has been gathering momentum and culminated in a largely attended meeting just held at the Engineers' Club, at which it was decided to form a provisional institute and committee to inquire into the best method of organizing qualified chemical engineers. The provisional committee includes Sir Arthur Duckham, Mr. Woolcock, M.P., William McNab, Mr. Reavell and Prof. Hinchley, who has done practically all the spade work. It was mentioned at the meeting that the American Institute might decide, in accordance with a suggestion made recently, to call itself "The Institute of Chemical Engineers," and it seems quite probable and possible to arrange ultimately for an institution which shall embrace affiliated branches in all English speaking countries, rather than to form separate bodies. The possibility of utilizing the Institute of Chemistry as a qualifying body has been mooted in the past, but the present feeling undoubtedly leans toward the institution idea, the Institute of Chemistry having shown little sympathy with the movement. On the other hand, chemical engineering education is notoriously behindhand and until and unless degrees on chemical engineering are provided, the qualification for membership must rest mainly on achievement and distinction.

### GENERAL PERSONAL NOTES

*The Times* Trade Supplement of Nov. 12 published a thoughtful article by Mr. Woolcock, M.P., general manager of the Association of British Chemical Manufacturers, in which the operation of the safeguarding of industries act is discussed in the light of the experience of the past two months. The attention of American readers may be drawn to the definitions of fine chemicals and the present position of synthetic camphor and milk sugar.

Something of a sensation was caused by the sudden reappearance of Dr. Paul Dvorkovitz, the well-known petroleum expert, who, after carrying out valuable work in the Allied interests in Russia, was definitely reported to have been shot by the Bolsheviks. One of the oldest members of the Society of Chemical Industry, Dr. Dvorkovitz received a warm welcome and entertained his many friends with details of his pleasant and unpleasant experiences in Russia.

### Increased Duties on Competitive German Products

Acting Commercial Attaché S. H. Cross of Brussels reports that an emergency tariff act was put into effect Nov. 7 which covers exclusively German manufactured products entering into direct competition with Belgian industries. It provides for increases of 100 to 300 per cent on articles assessed by weight, and advances many ad valorem duties to 20 or 40 per cent.

Textile, chemical and mechanical products are prominent among the German products which are to bear increased duties.

## The Aging of Rubber

Problems Arising in Studies of the Life of Rubber Goods—Methods of Testing—Aging Hypothesis—Additional Vulcanization by Oxygen—Depolymerization—Additional Vulcanization by Sulphur—Still and Active Aging Compared—Aging Under Strain

BY ANDREW H. KING

THE life of rubber goods is a subject of vital importance not only to rubber technologists but to the general public as well. The natural life of soft rubber goods seldom exceeds 30 years, but the average is much lower. For example, an average grade of garden hose seldom lasts more than 5 years, when it fails not from being worn out but because of certain changes which go on within the rubber compound. The cover will become checked or cracked and the tube and friction so stiff that the hose cracks open when bent. Similar conditions are found on some tires and occasionally on those of the best grades. Side-wall checking is usually the first warning of poor aging. One does not expect soft rubber goods to last forever, but just as in human life, there is a great divergence in mortality. There is a wide variation from brand to brand of the same article and not infrequently a variation just as wide in the product of the same manufacturer. In fact, there are cases where the article fails by bad aging before it is placed in service.

Bad aging can usually be traced to faulty materials or conditions of manufacture, but in many instances the conditions of service are responsible. In other cases the manufacturer has failed properly to appreciate the type of service desired and has produced an article designed for something else.

Naturally the blame for faulty aging from the manufacturer's standpoint falls on the rubber chemist. It is therefore not remarkable that at the last meeting of the Rubber Division of the American Chemical Society in New York the discussion on this subject was both extended and animated. It was characterized, however, by the wide divergence of opinions, ranging from the value of all artificial aging tests to the conditions deemed most suitable for performing them.

### METHODS OF TESTING

The adequate determination of the life and service of any soft rubber compound requires at least 1 year's exposure; it is better that the exposure be for 2 or 3 years. Of course this method is entirely unsuitable for development work. One wishes to know approximately how his product will stand up in service and he wishes this knowledge as quickly as possible. This is the reason for the large number of artificial age tests which as a rule are merely each investigator's own method of attack on the problem.

The greatest single contribution to our knowledge on this subject has recently been published under the caption "Ten Years' Experience With Age Tests," by Dr. W. C. Geer and W. W. Evans of the B. F. Goodrich Co. (*India Rubber World*, September, 1921, p. 887). Their method in brief consists of heating test-pieces of the various compounds in an oven at 160 deg. F. (71 deg. C.) with a constant supply of fresh air previously

heated to the same temperature. Up to 4 or 5 days, 1 day's heating appears to give the same deterioration in tensile strength as is met with in 6 months of natural life. The test is comparative and therefore must always be run in conjunction with the same type of compound whose aging in natural life is known.

Their ideas on the subject may be summarized as follows:

1. It is more reliable to plot deterioration in tensile strength against time of heating and to determine the aging characteristics from the curve than to make simply one or two determinations at definite time intervals. In other words, it is the trend of data that determines.
2. Samples are not hardened as in actual aging, but are definitely weakened.
3. Sulphur changes are noticeable, but were not considered important.
4. The artificial age test is considered more severe than natural life.
5. The test is of little value for compounds having a tensile strength less than 1,000 lb. per sq.in.
6. The authors are of the opinion that in the majority of cases of too rapid deterioration, this is due to overcure or undercure and in the majority of cases to over-vulcanization.

This paper was originally presented in England before the International Rubber Conference. The discussion that followed was quite interesting. Stevens stated he found that the moisture content of the air has a great effect on natural aging. Samples aged in moist air and immersed in water showed much lower deterioration than when exposed to heated air. Schidrowitz called attention to the absence of light in the test described above. DeVries stated that deterioration is more rapid in the tropics than in London. This may be due to more intense light. Dr. Geer in the course of further remarks mentioned that the current of heated fresh air in his test was very important and that it makes for uniformity of results. He also stated that fine para aged best, after which come the better grades of smoked sheets, which in turn are superior to pale crêpe.

### OBSERVATIONS ON AGING TESTS

From the discussion of the aging question in New York the following observations are in order:

1. The majority of the chemists present perform their accelerated age tests at 70 deg. C. or thereabout.
2. Other investigators employ a comparatively high temperature—e.g., 130 to 150 deg. C. Their theory is evidently to treat the samples more severely than will be met with in service.
3. An interesting and highly practical test was described by Dr. Somerville. Test-pieces were placed in

ordinary Mason jars and immersed in boiling water for various periods of time. At the beginning of the test the samples are exposed to oxidation as well as to the action of heat. Within a short time the oxygen disappears and further deterioration is due to heat alone.

4. Sanderson described a new type of oven in which dry air previously heated to the required temperature is supplied continuously. The oven is immersed in a thermostat for the accurate control of temperatures.

An outstanding feature of the remarks was that very few had any concrete ideas or theories as to what aging actually is or how it progresses. Naturally this is considerable to expect on a subject so little understood. However, it is true that more satisfactory progress is always obtained when a moderately simple hypothesis is adopted as a means of visualizing the problem in the beginning.

#### AGING HYPOTHESIS

It is with precisely this object in mind that the following is presented. Let us assume for the present that the deterioration of rubber with age is solely dependent on additional vulcanization subsequent to the normal "cure."

By vulcanization we mean the addition of a substance or substances to rubber which results in the production of a more elastic material—i.e., one with less plasticity. When the change becomes of sufficient magnitude that the product becomes of commercial value it is then known as "cure." It is well known that substances other than sulphur or sulphur chloride—for example, oxygen, chlorine, selenium, etc.—produce a change in plasticity—in other words, that they vulcanize—but the products obtained this way have not to date had any commercial value and therefore cannot be called "cured." In speaking of additional vulcanization it is to be understood that we are not limiting ourselves to sulphur or sulphur chloride.

In vulcanization by sulphur there are two ranges within which the products have commercial value. The first or soft rubber range contains compounds vulcanized so that they have from 1.5 to perhaps 4 per cent combined sulphur on the rubber. When reclaims are used, this figure goes up to 6 or 8 per cent combined sulphur. Above this point there is a long intermediate range where the products are without value. Then we come to the range of the ebonites, which will run from about 20 to as high as 47 per cent combined sulphur on the rubber.

For purpose of argument we may assume that we can have vulcanization—for example by oxygen—in addition to the sulphur cure which preceded it. We may even assume that under proper conditions it is possible for oxygen or other vulcanizing substances to saturate the remaining free bonds of the rubber and produce a material related to  $C_{10}H_{16}S_2$  (ebonite) or  $C_{10}H_{16}Br_2$ . Under the ordinary conditions of aging additional vulcanization by oxygen or by sulphur or by both are probably all that will be encountered.

Surface aging which results in a hardening and checking of the surface is probably due largely to additional vulcanization by oxygen. On the other hand, internal aging which lowers the tensile strength and the ultimate elongation is likely to be a combination of additional vulcanization by both sulphur and oxygen which may be released from the compounding ingredient or merely from the air dissolved in the stock during the milling. Such rubber has a perished smell and feel.

Additional vulcanization is probably affected by the following factors:

#### By Oxygen

- (a) Concentration and activity of oxygen.
- (b) Accelerators of oxidation such as
  - (1) Actinic light.
  - (2) Certain compounding ingredients—e.g., red lead.
  - (3) Impurities such as copper and manganese oxides or salts.
- (c) Depolymerization.

#### By Sulphur

- (a) State of cure.
- (b) Depolymerization.
- (c) Concentration and activity of sulphur.
- (d) Accelerators.
- (e) Heat.

Direct evidence of the combination of oxygen with rubber was found by Herbst (*Ber.*, 1906, vol. 39, pp. 523-525), who purified rubber by Harries' method—by dissolving in chloroform and precipitating with alcohol—which was repeated several times. The purified rubber he then dissolved in benzene, which cement was boiled under a reflux condenser; meanwhile passing dry washed air through the solution for 140 hours. On distilling off the benzene he found an increase in weight of 12.2 per cent. From the sirupy mixture of resinous bodies he was able to isolate two compounds having the empirical formulas  $C_{10}H_{16}O$  and  $C_{10}H_{16}O_2$ . The latter he found to correspond in its properties to Spiller's resin.

An indirect evidence of vulcanization by oxygen is found in the scorching or lumping with change in elasticity, etc., sometimes noticed when large amounts of carbon black are milled into rubber without proper care in handling.

The action of ozone on rubber is well known. One molecule of  $O_3$  adds on at each double bond. Ozone is extremely active. Obviously additional vulcanization by oxygen depends in a great measure on the concentration of oxygen present. In fact all protective coatings which retard or prevent surface aging do so by excluding oxygen.

#### ACCELERATION OF OXIDATION

*Actinic Light.*—Light is perhaps the most powerful catalyst of oxidation known. C. O. Weber (*J. Soc. Chem. Ind.*, 1903, p. 875) described experiments in which thin films of para, both crude and milled, vulcanized and unvulcanized, were exposed to light for 50 days. The acetone extracts of the samples were determined at intervals. His conclusions were:

1. That unvulcanized rubber was more liable to oxidation than vulcanized due to lower saturation state.
2. The longer rubber is milled on hot rolls the higher the acetone extract. With very excessive working the extract becomes gummy and not resinous, as is the case with truly oxidized rubber. Weber considered the increase in extract as due to the decomposition of the rubber molecule.
3. Overworked rubber oxidizes very rapidly, yielding after 50 days' exposure 38.7 per cent extract against 5.7 per cent when properly milled.
4. The lower the degree of vulcanization (probably referring to undercure) the faster the oxidation.

Additional evidence is furnished by Gorter (*Gummi Zeit.*, vol. 30, p. 351, 1916), who exposed samples of rubber to light in sealed tubes containing air, oxygen, carbon dioxide and hydrogen. The rubber became tacky only in those tubes containing air or oxygen. Oxidation proceeded slowly during the first 6 days, then more rapidly, reaching a maximum in about 30 days.

The presence of aldehydes in the tacky rubber was established.

Since light has the property of accelerating oxidation, it is to be expected that increased oxidation would result with an increase in the ultraviolet. That this is so was shown by Henri (*Le Caout. et Gutt. Percha*, 1910, vol. 7, pp. 4371-4376), who exposed sheets of fine para, pale crêpe, hevea latex evaporated on glass, rubber cement evaporated on glass and sheets containing various minerals to the action of light rich in ultraviolet, secured from a mercury vapor lamp placed 20 cm. from the samples. He found:

1. Unvulcanized rubber suffers visible deterioration in 20 hours. It darkens and becomes shiny. The surface cracks when sample is stretched.
2. Action is superficial only, with brown cut sheets.
3. But with pale sheets it penetrates quickly.
4. Vulcanized rubber requires 48 to 72 hours' exposure for deterioration to become noticeable.
5. Minerals slow down the action in some cases. Thus litharge tends to restrict and antimony pentasulphide to increase the oxidation.
6. Rubber from solution in naphtha is more easily attacked than the undissolved.
7. He concluded that the change is due to oxidation, which is accelerated by ultraviolet rays.

8. The most active rays have a wave length of less than 3,600 Angstrom units and are not screened off by thin sheets of glass. Absorption of oxygen by a very pale sample was found to begin at a wave length of 3,650 units. As rubber darkens in color the absorption of ultraviolet rays increases.

9. Due to the fact that ultraviolet concentration is greater with higher altitudes, balloon fabrics should be coated with an ultraviolet screen containing pigments such as lead chromate or aniline yellow.

*Certain Compounding Ingredients.*—Red lead ( $Pb_2O_3$ ) was at one time rather extensively employed. However, it was found that most stocks containing it failed from internal aging.

An example of oxygen vulcanization is found in Ostromuislenski's mono- and di-nitrobenzene processes, in which litharge plays the part of a catalyst of oxidation. The oxygen comes from the di- or mono-nitrobenzene, the reduction products of which may be determined in the vulcanized compound.

*Impurities.*—Copper and manganese compounds and probably alkali are other catalysts of oxidation which are occasionally found as impurities in various compounding ingredients. Apparently not all compounds of manganese have this effect, for a certain zinc oxide which gives compounds of excellent life contains traces of manganese.

#### DEPOLYMERIZATION

The conception most generally held is that the colloid rubber is made up of colloidal aggregates of unknown but possibly varying size. These aggregates probably consist of a large number of  $C_{10}H_{16}$  molecules linked up through the partial valences of the double bonds, of which there are two to each molecule. We may write rubber as  $(C_{10}H_{16})_n$ , where  $n$  represents the number of molecules in the aggregate.

The tying up of the rubber molecules into the colloidal aggregates renders them less reactive due to local saturation of the partial valences. A somewhat analogous case is found in the benzene ring, which contains three double bonds yet does not react very readily

until something happens to break in some way the local or self-saturation of the partial valences of these bonds.

By depolymerization we mean the splitting up of the aggregates into others of smaller size. In ordinary milling the "breaking down" or plasticizing of the rubber probably corresponds to a reduction in size proportional to a change from  $n$  of 3,000 to one of 2,500. There is doubtless some relation between increase in plasticity and decrease in size of the aggregate. Within small limits there is the property of partial recovery. Thus milled stocks harden on standing. The change is probably proportional to an increase of  $n$  to 2,800. Partial recovery decreases with the severity of treatment. There is evidently a limit below which rubber remains permanently soft and tacky.

Polymerization is without doubt the greatest unsolved mystery of rubber chemistry. We know how to reduce it, but no one to date has shown how it may be increased without introducing some material as for example sulphur, which polymerizes by tying up the loose ends, or as may be better described, the locking of one molecule to another through their double bonds. Unfortunately sulphur when once in place so far has refused all invitations to let go its grip.

#### FACTORS AFFECTING DEPOLYMERIZATION

The factors affecting depolymerization are temperature, time and solvents. It appears to be nothing more than a physical separation of the aggregates into smaller units. It ought therefore to be proportional to the time and temperature of heating. The higher the temperature or the longer the period of heating the greater should be the depolymerization.

In normal vulcanization by sulphur we have two reactions, that of heat, which produces depolymerization, and that of sulphur, which increases the polymerization as described above. Naturally the shorter the time or the lower the temperature the less the depolymerization and therefore the less sulphur required to combine with the rubber to produce a normally cured product.

The depolymerizing properties of certain solvents are probably due to similar causes. Perhaps the most likely theory is that the rubber absorbs the solvent and swells in much the same manner as gelatine swells when immersed in water. The volume of the gel increases, but the total volume of gel plus water decreases—i.e., the process is accompanied by compression. The force exerted is terrific and probably runs into the hundreds of atmospheres. There is an evolution of heat, which in the case of gelatine amounts to 5.7 gram-calories per gram of gel. Swelling of rubber in solvent brings about a separation or dissociation of the molecules in the aggregates.

As pointed out above, depolymerization is a separate and distinct reaction from vulcanization. No matter how carefully vulcanized a product may be, if it is exposed to excessive heat or to certain solvents it will become depolymerized. This within small limits is probably harmless. Its bad effect, however, is that it opens up double bonds and makes them available for addition. This will take place with sulphur if there is sulphur and a sulphur catalyst available. If not, oxidation will begin. It is for this reason that most compounders try always to have a small residuum of free sulphur in their compounds.

It will be noticed in the experiments described under the effect of light and also under accelerated age tests that the samples became soft, tacky or weakened. Ap-

parently in these cases the rate of depolymerization exceeded that of addition of oxygen. In natural life tests perished rubber is most always hard and practically brittle. It has a characteristic odor. It is reasonable to suppose that the difference is due merely to the period of exposure and that, given time enough, the soft, tacky samples would also have become hard.

#### ADDITIONAL VULCANIZATION BY SULPHUR

*State of Cure.*—Additional vulcanization by sulphur is the principal factor in internal aging. Dr. Geer's statement that the cause of most bad aging is due to an overcure or an undercure and usually to an overcure is only too true. The uninitiated sometimes prefer a stock cured so that it has a great deal of snap. This is wrong, because the point of maximum snap lies on the overcured side. The correlated opinion of men who have been a long time in the business is that the best cure from an aging standpoint is a little short of that cure giving maximum tensile strength. The cure giving from 10 to 15 per cent less tensile than the maximum is usually preferred.

A study of the bloom is also helpful. This term is given to the deposit of sulphur which condenses on the surface after the cure to a more or less extent, depending on the amount of free sulphur remaining in the stock. It is usually desirable to examine stocks for bloom about 6 weeks subsequent to vulcanization. Many experienced compounders can pick out the best cure of a stock by simple appearance of sheets cured at different times, after the bloom has had an opportunity to develop. In very few cases will the non-blooming stocks be chosen, because in many instances they will be found to be overcured. Nor will those having a pronounced bloom be selected, for the reason that their cure is probably under. In most cases the optimum cure will be taken as the one where a slight but not excessive bloom is in evidence. In compounds becoming non-blooming in about 2 hours and 30 minutes curing time at 141 deg. C., this point will be found about 15 minutes previous to the non-blooming cure.

The best types of antimony tubes are practically but not quite non-blooming. But antimony sulphide is a special compounding ingredient. It appears to act as a stabilizer. For example, the theory is that as the tube becomes depolymerized because of the heat and flexing, the pentasulphide decomposes slowly and the liberated sulphur adds on to the rubber, thus neutralizing the effect of depolymerization. This theory has been advanced as a solution of the problem why antimony tubes maintain about the same physical properties over a long period of time. Some tubes are known to have been in service for more than 10 years without any serious deterioration. There are other substances which are even better stabilizers than antimony sulphide, as for example certain organic accelerators.

Many rules have been given for the proper free sulphur content. In many if not in all cases they are positively worthless, because free sulphur content is not nearly the whole story. The nature and amount of accelerator remaining after the cure are of equal if not paramount importance. Nor is the coefficient of vulcanization in itself a reliable criterion. This coefficient—the name given by C. O. Weber to the per cent combined sulphur based on the rubber—is very low. A good commercial cure may be obtained with a coefficient of but 1.5. On the other hand, such a compound will be badly overcured when a coefficient of 2.5 is reached.

In Weber's day this value was the minimum coefficient with which a commercial product could be obtained.

*Depolymerization.*—This subject has been discussed at some length above. Practically all the remarks apply to addition of sulphur as well as of oxygen. Perhaps the only difference is that with sulphur alone there is a temperature coefficient that prevents the addition of sulphur until a definite temperature is reached. On the other hand, there are so many powerful accelerators which work well at low temperatures that in most cases depolymerization is a decided factor in internal aging. This is particularly the case for those compounds containing substances known to be violent depolymerizers such as certain grades of rosin oil.

*Concentration of Sulphur. Accelerators.*—These subjects are so interwoven that it is almost hopeless to separate them. For a time the tendency was to make practically non-blooming stocks by the aid of powerful organic accelerators. Older compounders have always insisted on a liberal supply of bloom. Today it is believed that an intermediate position is most desirable. The proper accelerator and sulphur ratios can be determined only by long experience. A compound should stand 100 to 200 per cent overcure without serious deterioration in physical properties.

*Heat.*—As is well known, heat speeds the reaction of sulphur with rubber during the cure. It also has a similar effect in speeding after vulcanization, but to a much less extent than at the normal curing temperatures. From an aging standpoint its worst effect is as a depolymerizer.

#### COMPARISON BETWEEN STILL AND ACTIVE AGING

A peculiar and apparently inexplicable phenomenon is the fact that rubber resists age better when in use than when idle. It is well known that a spare tire ages badly in comparison to its sister on the wheel in service.

Just why this is so is not yet known. The temperature of the exhaust is perhaps a small factor. But a more likely theory is that some internal rearrangement has taken place within the rubber itself. The stresses of a tire in service are greatly different from one held in reserve as a spare. In the latter case the entire carcass is under strain from the inside. This permits the tire to take a set along certain lines. When put in service the stresses are from an opposite direction and failure soon occurs. The exact cause of the trouble, as mentioned above, is not known. In the meantime it will be found desirable to keep spares covered and to put them in service at least every 3 months.

It has been observed that many otherwise good aging compounds when placed under strain, even so slight as when an 8-in. sheet is bent double, and exposed to the weather soon develop serious cracks and checks at the location of greatest tension—i.e., on the outside of the bend. Just why this is so is not yet known.

#### CONCLUSION

Several ideas as to the cause and mechanism of aging have been correlated. The hypotheses advanced are not considered as proved, but are merely tenable in the light of present knowledge.

There is no more serious problem facing rubber manufacturers and consumers today than the study of aging. It may be said without fear of contradiction that the average life of soft rubber goods as prepared at present could be greatly increased without much effort.

## On the Heat-Treatment of Aluminum Bronze

**Exceptionally High Values Given in Handbooks for Strength of This Alloy Led to an Extensive Investigation of the Alloy for Use in Lifting Jacks—Hardness and Strength of These Bronzes Appear to Be Independent Variables**

BY A. A. BLUE  
Metallurgist

MUCH valuable work has been done and published on the heat-treatment, with its attendant changes in structure and physical properties, of what is known as "aluminum bronze," an alloy of the general analysis: copper, 90 per cent; aluminum, 10 per cent, with occasionally 1 per cent iron substituted for a corresponding amount of copper. Under the necessity of producing lifting jacks of ever-increasing capacity with decreased weight, this alloy has been experimented with in various structural conditions. Since the large majority of the available data on this subject is made up from laboratory work done on small pieces, especially prepared, the results of the present investigation are offered, not with the idea of presenting considerations essentially new, but in the hope they may be of value to those who are interested primarily in the commercial application of this interesting material and in the results they may expect to obtain under actual conditions of everyday manufacture and treatment. Reference to the literature on heat-treatment of aluminum bronze reveals differences in opinion as to the nature of the changes involved and also as to the results obtainable from various treatments. After being unable to check some published results of treatments when applied in practice, a rather complete investigation was determined upon.

### CU:AL EQUILIBRIUM DIAGRAM

The theoretical considerations are embodied in the constitutional diagram shown in Fig. 1, taken, with a slight modification, from Greenwood<sup>1</sup>. This arrangement was in turn prepared from the work of Curry<sup>2</sup>, Carpenter and Edwards<sup>3</sup>, and Andrew<sup>4</sup>. The constitution of the alloys of copper and approximately 10 per cent aluminum consists of a series of solid solutions, the nature and designation of which have not been entirely agreed upon, but, as Fig. 1 is made up of what has been considered best in a number of the most carefully conducted works on the subject, it is probably very close to correct.

Alpha solid solution exists alone up to approximately 10 per cent aluminum, under conditions of equilibrium. An inclination in the boundary line exists above 1,050 deg. F. (566 deg. C.), thus permitting the appearance of the second phase, known as beta solid solution at higher temperatures. Curry<sup>2</sup> and Rosenhain<sup>5</sup> show this boundary line at approximately 8.5 per cent Al,

but the work of Greenwood demonstrated the difficulty of obtaining the alloy in equilibrium, which accounts for the different locations of this line. The present work has been done with samples containing varying amounts of iron, which has also probably shifted the equilibrium. Increasing aluminum beyond 10 per cent produces a third solid solution known as delta, which forms a eutectic with alpha, the eutectic composition being approximately 12 per cent aluminum, as indicated in Fig. 1. Upon heating past the transformation temperature (1,050 deg. F., 566 deg. C.), the eutectic changes into the beta solution, which proceeds

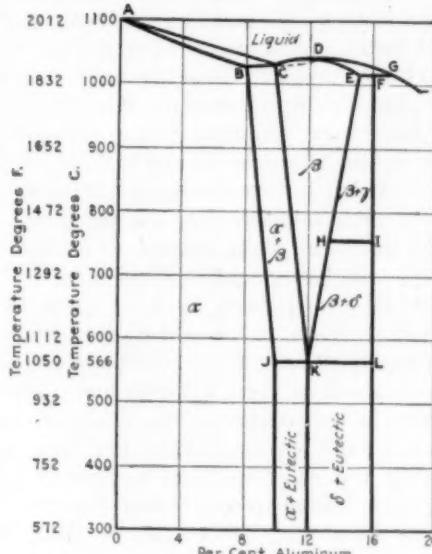


FIG. 1. PORTION OF THE CU:AL EQUILIBRIUM DIAGRAM, AFTER GREENWOOD<sup>1</sup>

to absorb increasing amounts of alpha or delta, whichever was the excess constituent, with increasing temperatures, as shown by the lines CK and KE. At 1,400 deg. F. (760 deg. C.) indicated by the line HI, the delta solution changes into a fourth form known as gamma. The melting point of the alloy is seen to be in the neighborhood of 1,900 deg. F. (1,040 deg. C.) along the line ABCDEG.

### MICROSCOPIC APPEARANCE OF CONSTITUENTS

The structural appearance of bronzes containing varying amounts of aluminum on both sides of the value represented by J is shown in Figs. 2 to 5 inclusive. Fig. 2 is of a sample containing 7.54 per cent Al; practically all of one constituent, with here and there a slight appearance of the eutectic. The round black spots are of lead, which is insoluble in copper. A somewhat larger amount of eutectic is visible with 8.39 per cent Al, though it may be largely

<sup>1</sup>Greenwood, "The Constitution of the Copper-Rich Aluminum Alloys," *J. Inst. Metals*, vol. 19, 1918, pp. 55-100.

<sup>2</sup>Curry, "The Constitution of the Aluminum Bronzes," *J. Phys. Chem.*, vol. 11, 1907, pp. 425-436; 461-491.

<sup>3</sup>Carpenter and Edwards, "On the Properties of the Alloys of Aluminum and Copper," Eighth Report to the Alloys Research Committee, *Proc. Inst. Mech. Engrs.*, vol. 72, 1907, pp. 57-269.

<sup>4</sup>Andrew, *J. Inst. Metals*, 1915, vol. 13.

<sup>5</sup>Rosenhain, "Introduction to Physical Metallurgy," p. 154.

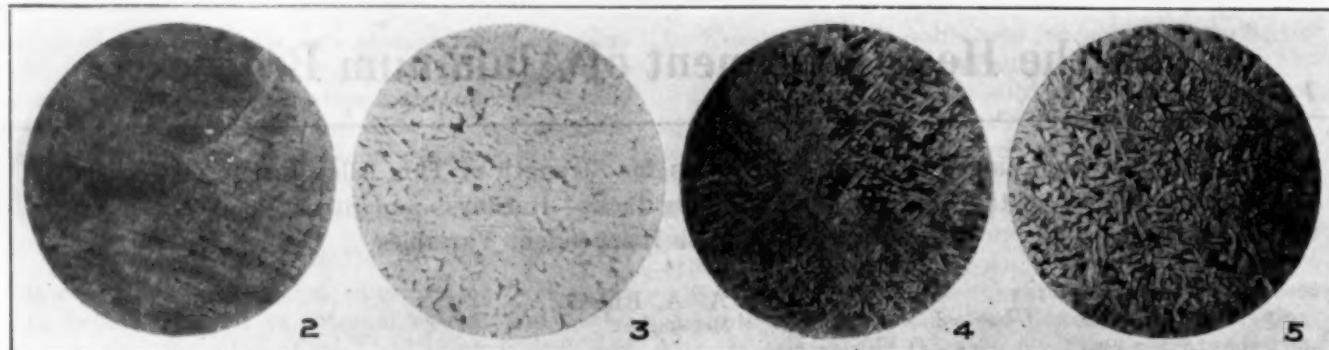
FIGS. 2 TO 5. MICROSTRUCTURE OF COMMERCIAL ALUMINUM BRONZES.  $\times 12$ 

Fig. 2. 7.54 per cent Al

Fig. 3. 9.48 per cent Al

Fig. 4. 0.76 per cent Fe

Fig. 5. 1.23 per cent Fe

masked by contrasty etching. Fig. 3 shows bronze containing 9.48 per cent Al; 10.4 per cent gives progressively increasing amounts of the black eutectic constituent. All of these samples contained approximately 0.5 per cent iron. Increasing the amount of iron appears to cause a bunching of the crystals around the large grain boundaries, as shown in Figs. 4 and 5, containing respectively 0.76 and 1.23 per cent iron.

All micrographs are after etching with  $\text{FeCl}_3$ , acidified with HCl.

The effect of heating the same samples is shown in Figs. 6 to 8 inclusive, all samples being heated to 1,600 deg. F. (870 deg. C.) and quenched in a 5 per cent brine solution. The eutectic is seen to have changed into the fine needle-like beta solution, which has in turn absorbed some of the adjacent alpha, so that the area of the beta is in all cases greater than that of the eutectic from which it was produced. Fig. 8 is practically complete beta solution. Along the grain boundaries a small amount of alpha reappears no doubt due to the quenching not being sufficiently rapid.

The results obtained from various rates of cooling are illustrated in Figs. 9, 10 and 11, showing, respectively, the structures resulting from quenching samples of the same composition from 1,550 deg. F. (845 deg. C.) in oil, water and salt water. The effect of annealing is to produce a very much refined structure, as shown in Figs. 12, 13 and 14 of samples heated to 1,550 deg. F. (845 deg. C.), cooled in air; 1,600 deg. F. (870 deg. C.), cooled in lime, and 1,700 deg. F. (925 deg. C.), cooled in lime, respectively.

As indicated by the inclined line *BJ* in Fig. 1, increased temperatures above 1,050 deg. F. (566 deg. C.) produce increased amounts of beta solution, which is retained upon quenching. The actual progression of this absorption is shown in the series Figs. 15 to 20, inclusive, of samples heated respectively to 1,250, 1,300,

1,400, 1,500, 1,600 and 1,700 deg. F., in each case being quenched in 5 per cent brine. Progressive disappearance of the alpha solution is seen up to the temperature of 1,600 deg. F. (870 deg. C.), when complete solution is found. Further heating above this point appears to develop a formation along the grain boundaries. Greenwood states that this is a reappearance of alpha. It is apparent, as noted above, that some alpha is to be expected due to the impossibility of retaining all in solution during quenching, just as it is practically impossible to obtain pure austenite in quenching carbon steels, but it appears difficult to justify a larger amount of alpha at higher temperatures than at lower ones, when just the reverse is to be expected. It

TABLE I. ANALYSES OF SAMPLES USED

Mark	Copper	Aluminum	Iron	Lead	Tin	Brinell Hardness (500 Kg.)
1	89.09	7.54	0.61	1.05	1.32	57
2	90.66	8.39	0.29	...	...	70
3	90.82	8.75	0.33	...	...	70
4	90.09	9.42	0.50	...	...	100
5	89.56	9.45	0.67	...	...	100
6	89.66	9.48	0.54	...	...	100
7	89.31	9.61	1.23	...	...	93
8	89.05	9.73	0.57	...	...	100
9	89.70	9.90	0.37	...	...	100
10	89.05	10.06	0.76	...	...	119
11	89.12	10.13	0.45	...	...	119
12	88.54	10.39	1.26	...	...	93

appears more reasonable to assume that this formation is due to a coagulation of the beta crystals themselves, with probably less alpha present than before. A number of specimens examined after such treatment showed a marked increase in this formation along the grain boundaries with the higher temperatures, so that the phenomenon is not accidental.

#### EXPERIMENTAL PROCEDURE IN QUENCHING

As noted above, samples of various analyses have been employed in the present discussion, coming from two foundries, one being an ordinary brass and bronze foundry and the other possessing an organization which has specialized on this alloy for a number of years. The analyses of the various samples used, together with the initial Brinell hardness figures, are shown in Table I. Greenwood found that samples 0.4 in. thick or larger

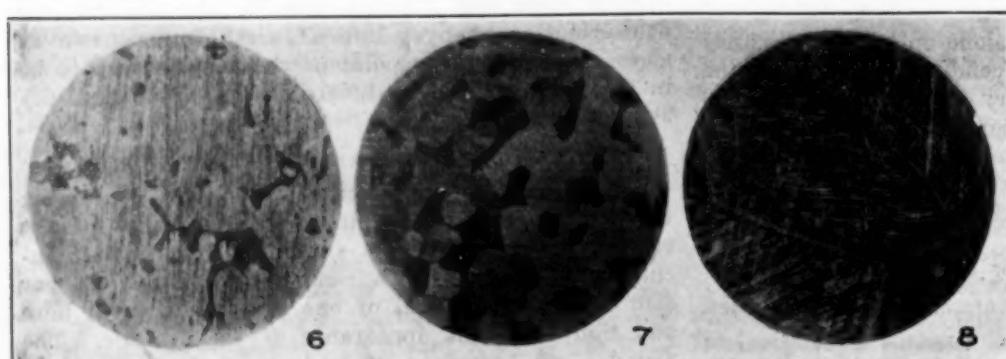
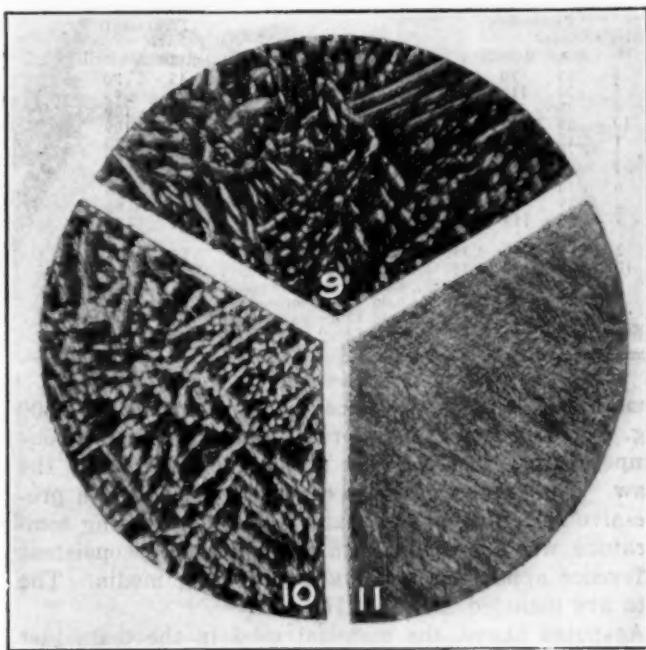
FIGS. 6, 7 AND 8. ALUMINUM BRONZES QUENCHED FROM 1,600 DEG. F.  $\times 50$ 

Fig. 6. 7.54 per cent Al

Fig. 7. 8.39 per cent Al

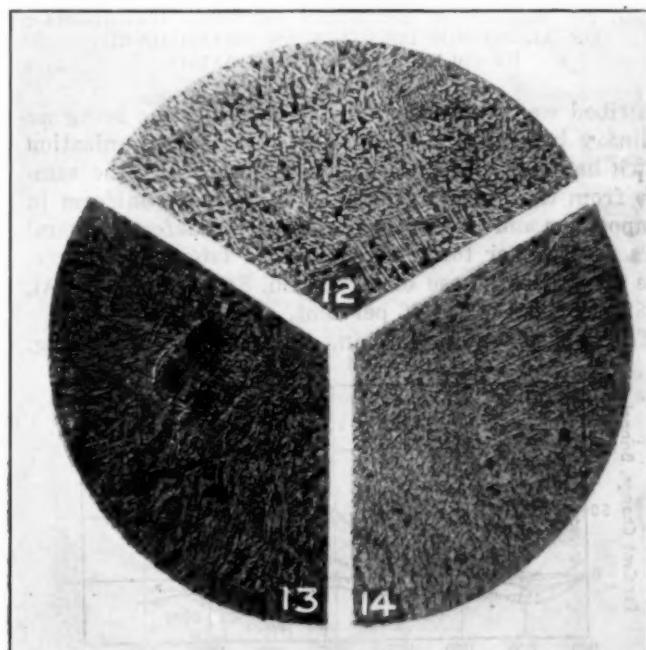
Fig. 8. 10.39 per cent Al



FIGS. 9, 10 AND 11. EFFECT OF COOLING RATE IN QUENCHING FROM 1,550 DEG. F. BRONZE CONTAINING 9.73 PER CENT AL.  $\times 25$

Fig. 9. Cooled in oil. Fig. 10. Cooled in water. Fig. 11. Cooled in brine.

could be used without affecting the scleroscope values obtained. Accordingly, a number of samples from  $\frac{1}{4}$  to  $\frac{1}{2}$  in. square were made up from castings of the above analyses. These samples were mixed indiscriminately, heated to various temperatures, and cooled at various rates, two samples being run for each condition. The samples were heated in an electric muffle, ample time being allowed for the metal to soak at the desired temperature; they were then rapidly removed to the proper cooling medium. If liquids (at room temperature) were the coolant, the piece was kept in constant motion during the cooling period. Temperatures were accurately controlled by a Leeds & Northrup poten-

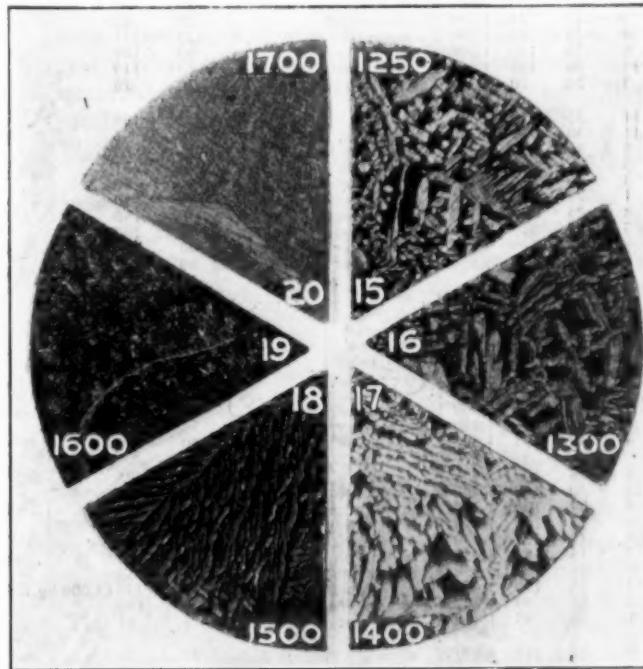


FIGS. 12, 13 AND 14. EFFECT OF ANNEALING BRONZE CONTAINING 10.13 PER CENT AL.  $\times 25$

Fig. 12. Cooled in air from 1,550 deg. F.  
Fig. 13. Cooled in lime from 1,600 deg. F.  
Fig. 14. Cooled in lime from 1,700 deg. F.

tiometer, the couple being in actual contact with the material in the furnace. The results of these tests, showing Brinell and scleroscope values before and after treatment, are shown in Table II. The magnifier hammer was used in all cases with the scleroscope, and the 500-kg. weight for the Brinell, except as noted when a corresponding correction was made, according to Fig. 21.

The results of the above series are plotted, Fig. 22 showing the increase in Brinell hardness and Fig. 23 in scleroscope. Due to the varying degree of hardness of the initial pieces, as a result of the increasing percentages of aluminum, the *percentage increase* in each case has been used, instead of the actual figures, as it was thought this would give a more accurate indication of the effects of the various conditions of treatment. Inasmuch as the samples lowest in aluminum showed no increase in hardness from treatments, these have been disregarded in plotting the curves. An examination of these curves shows a maximum harden-



FIGS. 15 TO 20. ABSORPTION OF ALPHA SOLUTION ON PROGRESSIVELY HIGHER QUENCHING. BRONZE CONTAINING 10.06 PER CENT AL.  $\times 25$

ing effect at from 1,550 to 1,600 deg. F. (860 deg. C.) for all rapid coolings; 5 per cent brine, water and oil producing hardening effects in that order.

Annealing produces a slight softening of the bronze with apparently little to choose between air and lime cooling.

A close examination of the plotted points shows a drop in the Brinell hardness when quenched from 1,400 deg. F. (760 deg. C.) in oil, water or brine. Seidell and Horvitz<sup>6</sup> show a similar drop, using straight aluminum bronze with no iron, at about 1,100 to 1,200 deg. F. (620 deg. C.). Greenwood's experiments showed that heating at 1,100 deg. F. (600 deg. C.) for 20 days was necessary to arrive at complete equilibrium. Heating to about 1,300 deg. F. (700 deg. C.) apparently permits this equalization to proceed more rapidly, resulting in the softening effect just mentioned.

A second series of tests was next made from the

<sup>6</sup>Seidell and Horvitz, "Relation of Microstructure to Phase Changes in Heat-Treated Aluminum Bronzes," CHEM. & MET. ENG., vol. 21, 1919, pp. 179-181.

TABLE II. HARDNESS OF ALUMINUM BRONZES BEFORE AND AFTER HEAT-TREATMENT

Analysis No.	Sclerometer No.	Hardness Before Treatment		Hardness After Treatment		Treatment	Brinell
		Brinell	Treatment	Brinell	Treatment		
3	20	70	1,200°F., air cool	20	65	1,700°F., air cool	15
4	20	100	1,200°F., air cool	20	86	1,700°F., lime cool	20
1	15	70	1,200°F., lime cool	20	61	1,700°F., lime cool	30
5	25	109	1,200°F., lime cool	20	93	1,700°F., water quench	15
8	30	100	1,200°F., oil quench	30	86	1,700°F., water quench	20
1	15	61	1,200°F., oil quench	15	29.7	1,700°F., salt water quench	45
2	20	70	1,200°F., water quench	20	74	1,700°F., salt water quench	30
6	30	93	1,200°F., water quench	30	86	1,700°F., salt water quench	85
2	15	70	1,200°F., salt water quench	20	61	1,700°F., salt water quench	70
11	30	130	1,200°F., salt water quench	35	114	1,700°F., salt water quench	158
8	30	100	1,250°F., air cool	30	74	1,780°F., hold 12 hr., air cool	15
6	25	100	1,250°F., air cool	25	80	1,780°F., hold 12 hr., air cool	20
2	20	70	1,250°F., lime cool	15	55	1,780°F., hold 12 hr., lime cool	30
6	25	100	1,250°F., lime cool	20	80	1,780°F., hold 12 hr., lime cool	65
11	40	119	1,250°F., oil quench	40	119	1,780°F., hold 12 hr., lime cool	57
8	25	100	1,250°F., oil quench	30	93	1,780°F., hold 12 hr., lime cool	15
8	25	100	1,250°F., water quench	30	100	1,780°F., hold 12 hr., water quench	30
2	20	70	1,250°F., water quench	20	65	1,780°F., hold 12 hr., water quench	109
8	25	100	1,250°F., salt water quench	30	100	1,780°F., hold 12 hr., water quench	30
10	30	119	1,250°F., salt water quench	50	143	1,780°F., hold 12 hr., water quench	119
10	25	119	1,300°F., air cool	30	119	1,780°F., hold 12 hr., water quench	15
3	20	70	1,300°F., air cool	15	61	1,780°F., hold 12 hr., water quench	61
4	20	100	1,300°F., lime cool	25	119	1,780°F., hold 12 hr., water quench	119
3	20	70	1,300°F., lime cool	15	61	1,780°F., hold 12 hr., water quench	119
4	25	100	1,300°F., oil quench	25	74	1,780°F., hold 12 hr., water quench	20
3	25	74	1,300°F., oil quench	20	65	1,780°F., hold 12 hr., water quench	65
1	25	45	1,300°F., water quench	20	31.2	1,780°F., hold 12 hr., water quench	31.2
8	35	100	1,300°F., water quench	40	109	1,780°F., hold 12 hr., water quench	109
11	30	119	1,300°F., salt water quench	40	119	1,780°F., hold 12 hr., water quench	119
3	20	70	1,300°F., salt water quench	20	70	1,780°F., hold 12 hr., water quench	119
11	35	119	1,350°F., air cool	32	109	1,780°F., hold 12 hr., water quench	119
11	30	119	1,350°F., air cool	30	93	1,780°F., hold 12 hr., water quench	93
5	30	93	1,350°F., lime cool	25	80	1,780°F., hold 12 hr., water quench	80
3	15	70	1,350°F., lime cool	10	61	1,780°F., hold 12 hr., water quench	61
3	20	74	1,350°F., oil quench	25	80	1,780°F., hold 12 hr., water quench	80
1	25	43	1,350°F., oil quench	20	50	1,780°F., hold 12 hr., water quench	50
8	25	100	1,350°F., water quench	40	130	1,780°F., hold 12 hr., water quench	130
5	30	119	1,350°F., water quench	35	100	1,780°F., hold 12 hr., water quench	100
8	25	100	1,350°F., salt water quench	40	119	1,780°F., hold 12 hr., water quench	119
6	30	100	1,350°F., salt water quench	30	109	1,780°F., hold 12 hr., water quench	109
2	15	70	1,400°F., air cool	10	50	1,780°F., hold 12 hr., water quench	50
8	20	86	1,400°F., air cool	20	100	1,780°F., hold 12 hr., water quench	100
5	25	100	1,400°F., lime cool	25	63	1,780°F., hold 12 hr., water quench	63
2	20	65	1,400°F., lime cool	15	54	1,780°F., hold 12 hr., water quench	54
11	40	119	1,400°F., oil quench	60	228 (3,000 kg.)	1,780°F., hold 12 hr., water quench	228
4	30	100	1,400°F., oil quench	32	100	1,780°F., hold 12 hr., water quench	100
4	30	100	1,400°F., water quench	35	109	1,780°F., hold 12 hr., water quench	109
5	35	119	1,400°F., water quench	45	130	1,780°F., hold 12 hr., water quench	130
6	35	86	1,400°F., salt water quench	35	93	1,780°F., hold 12 hr., water quench	93
6	30	93	1,400°F., salt water quench	40	74	1,780°F., hold 12 hr., water quench	74
4	30	100	1,450°F., air cool	30	93	1,780°F., hold 12 hr., water quench	93
10	30	119	1,450°F., air cool	30	109	1,780°F., hold 12 hr., water quench	109
8	20	100	1,450°F., lime cool	20	89	1,780°F., hold 12 hr., water quench	89
6	25	100	1,450°F., lime cool	25	86	1,780°F., hold 12 hr., water quench	86
4	30	100	1,450°F., oil quench	35	109	1,780°F., hold 12 hr., water quench	109
1	15	61	1,450°F., oil quench	15	61	1,780°F., hold 12 hr., water quench	61
5	35	100	1,450°F., water quench	45	158	1,780°F., hold 12 hr., water quench	158
11	25	119	1,450°F., water quench	65	255 (3,000 kg.)	1,780°F., hold 12 hr., water quench	255
6	25	93	1,450°F., salt water quench	35	130	1,780°F., hold 12 hr., water quench	130
1	20	43	1,450°F., salt water quench	15	45	1,780°F., hold 12 hr., water quench	45
6	25	93	1,500°F., air cool	20	93	1,780°F., hold 12 hr., water quench	93
2	18	70	1,500°F., air cool	15	57	1,780°F., hold 12 hr., water quench	57
1	20	43	1,500°F., lime cool	20	57	1,780°F., hold 12 hr., water quench	57
6	25	100	1,500°F., lime cool	25	80	1,780°F., hold 12 hr., water quench	80
3	15	70	1,500°F., oil quench	20	72	1,780°F., hold 12 hr., water quench	72
6	20	100	1,500°F., oil quench	30	100	1,780°F., hold 12 hr., water quench	100
6	20	74	1,500°F., water quench	25	93	1,780°F., hold 12 hr., water quench	93
5	30	100	1,500°F., water quench	45	143	1,780°F., hold 12 hr., water quench	143
5	30	100	1,500°F., salt water quench	50	150	1,780°F., hold 12 hr., water quench	150
4	25	86	1,500°F., salt water quench	50	143	1,780°F., hold 12 hr., water quench	143
10	25	119	1,550°F., air cool	20	109	1,780°F., hold 12 hr., water quench	109
11	35	119	1,550°F., air cool	30	119	1,780°F., hold 12 hr., water quench	119
4	30	100	1,550°F., lime cool	25	72	1,780°F., hold 12 hr., water quench	72
11	30	119	1,550°F., lime cool	30	109	1,780°F., hold 12 hr., water quench	109
8	30	100	1,550°F., oil quench	55	158	1,780°F., hold 12 hr., water quench	158
1	15	70	1,550°F., oil quench	15	54	1,780°F., hold 12 hr., water quench	54
3	20	70	1,550°F., water quench	25	86	1,780°F., hold 12 hr., water quench	86
5	25	100	1,550°F., water quench	45	158	1,780°F., hold 12 hr., water quench	158
10	35	119	1,550°F., water quench	60	207 (3,000 kg.)	1,780°F., hold 12 hr., water quench	207
10	35	119	1,550°F., salt water quench	65	188	1,780°F., hold 12 hr., water quench	188
2	20	70	1,600°F., air cool	15	54	1,780°F., hold 12 hr., water quench	54
11	25	119	1,600°F., air cool	25	100	1,780°F., hold 12 hr., water quench	100
1	25	65	1,600°F., lime cool	20	54	1,780°F., hold 12 hr., water quench	54
10	35	119	1,600°F., lime cool	30	119	1,780°F., hold 12 hr., water quench	119
11	30	119	1,600°F., oil quench	65	158	1,780°F., hold 12 hr., water quench	158
8	30	100	1,600°F., oil quench	45	130	1,780°F., hold 12 hr., water quench	130
4	20	100	1,600°F., water quench	50	158	1,780°F., hold 12 hr., water quench	158
4	25	100	1,600°F., water quench	40	130	1,780°F., hold 12 hr., water quench	130
11	25	119	1,600°F., salt water quench	85	192	1,780°F., hold 12 hr., water quench	192
10	25	119	1,600°F., salt water quench	85	269 (3,000 kg.)	1,780°F., hold 12 hr., water quench	269
4	20	100	1,650°F., air cool	20	80	1,780°F., hold 12 hr., water quench	80
8	30	100	1,650°F., air cool	25	100	1,780°F., hold 12 hr., water quench	100
11	35	119	1,650°F., lime cool	25	109	1,780°F., hold 12 hr., water quench	109
1	15	70	1,650°F., lime cool	15	57	1,780°F., hold 12 hr., water quench	57
5	30	100	1,650°F., oil quench	40	100	1,780°F., hold 12 hr., water quench	100
3	25	74	1,650°F., oil quench	25	80	1,780°F., hold 12 hr., water quench	80
2	25	70	1,650°F., water quench	20	80	1,780°F., hold 12 hr., water quench	80
3	25	70	1,650°F., water quench	30	100	1,780°F., hold 12 hr., water quench	100
10	25	119	1,650°F., salt water quench	70	202 (3,000 kg.)	1,780°F., hold 12 hr., water quench	202
11	35	119	1,650°F., salt water quench	85	217 (3,000 kg.)	1,780°F., hold 12 hr., water quench	217

Analysis No.	Sclerometer No.	Hardness Before Treatment			Treatment	Brinell	Hardness After Treatment Sclerometer No.
		Brinell	Sclerometer	Brinell			
3	15	70	1,700°F., air cool	15	70	1,700°F., air cool	15
5	20	119	1,700°F., lime cool	20	93	1,700°F., lime cool	20
8	20	86	1,700°F., lime cool	20	100	1,700°F., lime cool	30
10	35	119	1,700°F., lime cool	35	109	1,700°F., lime cool	30
1	15	57	1,700°F., oil quench	15	70	1,700°F., oil quench	15
3	18	70	1,700°F., oil quench	18	80	1,700°F., oil quench	20
1	15	57	1,700°F., water quench	15	61	1,700°F., water quench	20
6	30	100	1,700°F., water quench	30	130	1,700°F., water quench	45
2	25	70	1,700°F., salt water quench	25	80	1,700°F., salt water quench	30
5	35	119	1,700°F., salt water quench	35	109	1,700°F., salt water quench	30
1	15	57	1,700°F., salt water quench	15	70	1,700°F., salt water quench	15
2	15	70	1,780°F., hold 12 hr., air cool	15	61	1,780°F., hold 12 hr., air cool	15
10	28	119	1,780°F., hold 12 hr., air cool	28	119	1,780°F., hold 12 hr., air cool	30
3	20	80	1,780°F., hold 12 hr., lime cool	20	65	1,780°F., hold 12 hr., lime cool	20
2	20	65	1,780°F., hold 12 hr., lime cool	20	57	1,780°F., hold 12 hr., lime cool	15
8	25	100	1,780°F., hold 12 hr., lime cool	25	109		

TABLE III. HARDNESS OF ALUMINUM BRONZES BEFORE AND AFTER QUENCHING 1,600 DEG. F. IN SALT WATER AND DRAWING AT VARIOUS TEMPERATURES

Analysis No.	Before Treatment	After Quench			After Draw Brinell	
		Scleroscope	Scleroscope	Brinell		
1	20	45	800°, lime cool.	20	15	50
10	25	119	800°, lime cool.	60	55	228 (3,000 kg.)
6	25	100	800°, air cool.	40	40	130
2	20	70	800°, air cool.	20	20	72
2	15	70	800°, water cool.	20	15	70
10	25	86	800°, water cool.	60	55	158
5	35	100	900°, lime cool.	50	40	158
2	15	57	900°, lime cool.	10	15	40
5	25	93	900°, air cool.	50	40	119
1	15	70	900°, air cool.	15	15	57
10	25	109	900°, water cool.	70	45	158
4	25	100	900°, water cool.	45	35	119
J1	30	119	1,000°, lime cool.	65	40	179 (3,000 kg.)
J0	35	119	1,000°, lime cool.	70	40	150
1	15	70	1,000°, air cool.	15	15	65
8	20	100	1,000°, air cool.	45	32	130
3	20	74	1,000°, water cool.	25	20	86
J0	32	119	1,000°, water cool.	80	50	158
5	25	100	1,100°, lime cool.	60	35	109
11	30	119	1,100°, lime cool.	60	35	109
5	30	100	1,100°, air cool.	60	40	130
4	25	100	1,100°, air cool.	45	30	109
4	30	100	1,100°, water cool.	50	35	109
3	20	70	1,100°, water cool.	25	20	74

and were quenched at varying rates from two temperatures, 1,600 deg. and 1,780 deg. F. (870 and 970 deg. C.) respectively; then drawn back to various temperatures, again with different rates of cooling after the draw. The bars were then cut into test bars as follows:

**Tensile Tests.** The central portion was turned down to the standard 0.505 in. diameter, allowing 2 in. for the determination of elongation.

**Compression Tests.** Test-pieces  $\frac{1}{2}$  in. long by  $\frac{1}{4}$  in. diameter were prepared.

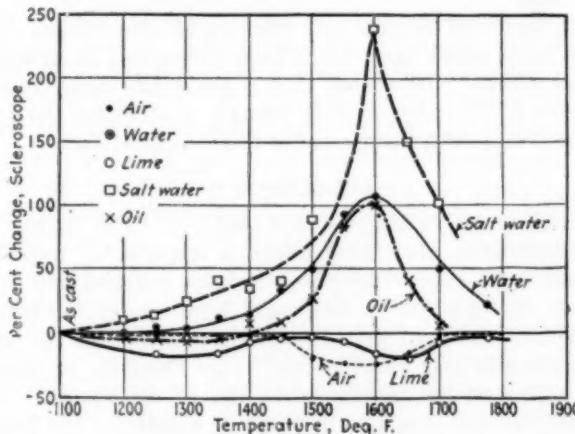


FIG. 23. CHANGE IN SCLEROSCOPE HARDNESS OF ALUMINUM BRONZES AFTER COOLING AT DIFFERENT RATES

**Impact Tests.** Charpy test-pieces were prepared, 10 mm. square with a standard notch, 1 $\frac{1}{2}$  mm. wide by 5 mm. deep.

All test-pieces were very carefully machined, being held accurately to the dimensions given, plus or minus 0.0005 in. Brinell tests were also made on these bars, using 3,000 kg. in all cases except the untreated bar. The results are plotted in Fig. 24. It is seen that a draw to 700 deg. F. (370 deg. C.) renders the material

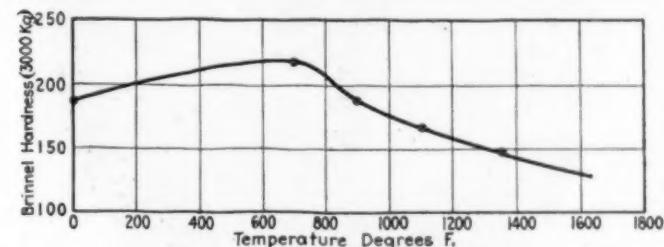


FIG. 24. EFFECT OF DRAWING ALUMINUM BRONZES AFTER QUENCHING IN WATER FROM 1,600 DEG. F.

harder than it was after the quench alone. A similar result is reported by Corse and Comstock<sup>1</sup> and by Portevin and Arnon<sup>2</sup>, although Seidell and Horvitz<sup>3</sup> found no such effect.

#### POOR CORRELATION OF PHYSICAL PROPERTIES

The tensile results, together with the other values obtained from this series of tests, are shown in Table IV. These figures present rather surprising results. In the first place, the large number of piped and defective pieces coming from a manufacturer with much experience indicates most forcibly the difficulty of handling this material in the foundry. However, the absence of all relation between Brinell hardness and tensile properties and between tensile properties and treatment is indeed unexpected. One feature especially peculiar (and apparently consistent) is the inverse ratio found between tensile strength and yield point. While the Brinell and scleroscope values respond very readily to treatment, they do not indicate any corresponding tensile strength and yield point, as they do with steel.

The above tensile tests were made on bars which had simply been turned down in the center. It was felt that possibly the low results were due to inequalities in the pull exerted by the testing machine. Therefore a number of threaded-end test-bars were prepared from addi-

<sup>1</sup>Corse and Comstock, "Aluminum Bronzes: Some Recent Tests and Their Significance," Proc. A.S.T.M., vol. 16, Part 2, 1916, pp. 118-144.

<sup>2</sup>Portevin and Arnon, Comp. rend., vol. 154, 1912.

<sup>3</sup>See footnote 6.

TABLE IV. PHYSICAL PROPERTIES OF HEAT-TREATED ALUMINUM BRONZE

No.	Treatment	Brinell	Ultimate Strength	Yield Point	Elongation, per Cent	Reduction in Area, per Cent	Compressive Strength, Lb. per Sq. In.	Impact Strength, Ft.-Lb. per Sq. In.
158	As cast.....	93	61,000	19,000	20.5	24.5	190,950	229
159	1,600° water.....	187	53,000	23,000	Outside mark		150,550	130
160	1,600° oil.....	156	64,100	16,000	Outside mark*		120,500*	190*
161	1,600° brine.....	255	69,500	20,000	3.0	7.0	118,350*	117
162	1,600° water; 700° air.....	217	41,600	27,500	Outside marks		145,800	149*
163	1,600° water; 900° air.....	187	69,550	25,000	Outside marks*		169,675	43
164	1,600° water; 900° lime.....	187	45,875	26,000	Outside marks*		161,225	55*
165	1,600° water; 1,100° air.....	163	73,875	19,000	12.5	18.0	188,575	249
166	1,600° water; 1,100° lime.....	170	51,500	30,000	3.5	10.0*	186,375	174*
167	1,600° water; 1,350° air.....	149	54,650	21,000	13.0	22.0*	197,625	310*
168	1,600° water; 1,350° water.....	187	66,500	22,500	15.5	18.0	143,900	192*
169	1,780° water.....	187	77,400	21,000	9.0	16.0	164,000	174
170	1,780° brine.....	174	53,000	28,000	Outside marks		93,475*	200*
171	1,780° water; 900° air.....	179	59,250	31,500	2.5	3.0*	130,900*	51
172	1,780° water; 900° lime.....	187	76,050	25,000	4.0	8.0	168,350	38
173	1,780° water; 1,100° air.....	170	58,575	24,500	8.5	15.0	169,450*	
174	1,780° water; 1,100° lime.....	149	65,500	27,500	13.0	19.0	167,875*	220*
175	1,780° water; 1,350° water.....	166	56,500	23,500	3.0	7.0	159,125*	142

\* Pipe or blow hole in specimen.

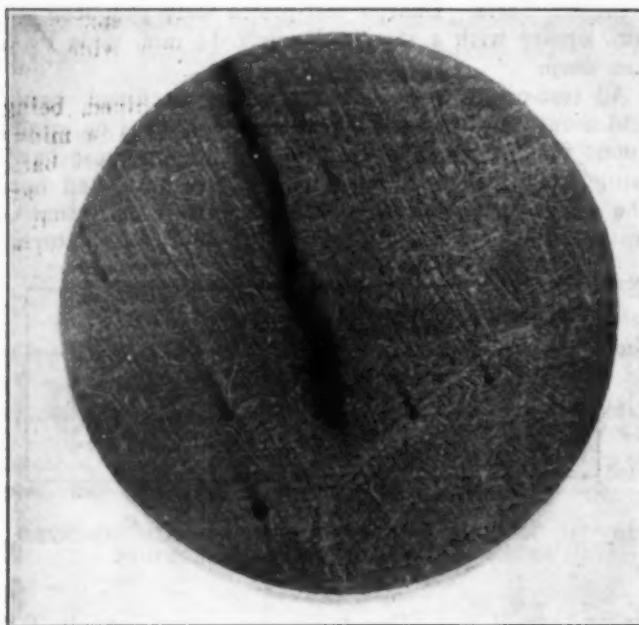


FIG. 25. TRANSGRANULAR FRACTURE IN ALUMINUM BRONZE.  $\times 100$

tional bars, cast with especial care to avoid all foundry defects. These bars showed an improvement in the condition of the metal after heat-treatment, as shown by figures for elongation and reduction in area, but the tensile strength and yield point were practically unaffected. Typical results were as follows:

Heat to 1,700 deg. F., quench in brine; draw at 1,000 deg. F., cool in lime.

Brinell hardness 179 (3,000 kg.).

Tensile strength, 81,495 lb. per sq.in.; yield point, 32,500 lb. per sq.in.; elongation, 22.5 per cent; reduction in area, 23.7 per cent.

Tensile strength, 79,480 lb. per sq.in.; yield point, 20,000 lb. per sq.in.; elongation, 20 per cent; reduction in area, 22 per cent.

Such results do not warrant discarding the first results obtained with the plain end test-bars.

Compression and impact results listed in Table IV indicate a draw at approximately 1,100 deg. F. (595 deg. C.) to give the best results. The increased brittleness shown by the impact test with a draw at 900 deg. F. (480 deg. C.) is very marked. This is of the same nature as the increased Brinell hardness with low draws, shown in Fig. 24.

Results obtained from castings made for lifting jacks substantiated the above results. The castings in question carry the entire load on the jack, delivering the load to a screw turning in the bronze casting. These castings were treated under all reasonable quenching temperatures, drawing temperatures and cooling rates from both heats. Brinell hardness figures corresponding to those given above for the test-bars were consistently obtained on the castings, but they all failed in service tests at approximately the same load, untreated doing as well as treated.

#### FRACTURE IS TRANSCRYSTALLINE

The failure of treated castings demonstrated a point of interest and one in accord with theory. Examination of fractures, as shown in Fig. 25, show the break to pass through the grains and not along the boundaries. This is as would be expected from theoretical considerations, inasmuch as the hard brittle beta is in the interior of the grain, while the softer more ductile alpha solu-

tion commences its formation along the grain boundaries, thus increasing the toughness at these points.

One of the prominent engineering handbooks on the market gives 100,000 lb. per sq.in. tensile strength to be expected from forged aluminum bronze. Actually to test this, bars 1 in. in diameter were forged at a temperature of 1,600 to 1,700 deg. F. to  $\frac{1}{4}$  in. in diameter, treated as indicated in Table V, and turned to standard 0.505-in. threaded-end test-bars. The forged structure had a marked grain refinement, and the results

TABLE V. PROPERTIES OF FORGED ALUMINUM BRONZE

Treatment	Tensile Strength, Lb. per Sq.In.	Elastic Limit, Lb. per Sq.In.	Elongation, per Cent	Contraction in Area, per Cent
Forged, untreated.....	79,750	34,360	32.5	34.8
Forged, untreated.....	81,245	34,240	31.0	30.8
Forged, reheated to 1,650 deg. F., quenched in brine, drawn to 1,000 deg. F., cooled in lime.....	92,190	44,820	Broke outside gage marks.	
Forged, reheated to 1,650 deg. F., quenched in brine, drawn to 1,000 deg. F., cooled in lime.....	81,345	43,820	Broke outside gage marks.	
Drawn to 1,000 deg. F., cooled in brine	86,490	47,760	12.0	14.9

show some improvement in tensile properties, but an increase in brittleness in the heat-treated specimens; compare cast and forged bars, quenched and drawn to 1,000 deg. F. (540 deg. C.) cooled in lime. A small increase in tensile strength is accompanied by a 40 per cent drop in elongation. Likewise the bar quenched and not drawn shows a considerable increase in strength, but was so brittle that it broke at the end, even though threaded-end test-bars were used and generous fillets provided.

The fact that mechanical working of the bronze produces little effect upon its tensile properties is brought out by Corse<sup>10</sup>; he states that rolling has been found to be of little value in this regard, describing the circumstance as a "remarkable metallurgical fact."

#### CONCLUSION

In conclusion it may be said that: (1) The theory of the copper-rich aluminum alloys is apparently well developed. (2) Heat-treatment produces marked and consistent changes in Brinell and scleroscope hardness. (3) Heat-treatment produces little or no effect on tensile strength and yield point. (4) Forging produces little effect on the tensile properties of the alloys. (5) Aluminum bronze is very difficult to handle in the foundry and at present yields uncertain results. (6) Figures have been published on the value of this alloy which cannot be readily duplicated in actual practice or tests.

#### World Reserves of Water Power

The Siemens Schuckert Co. has compiled data on the world reserves of water power. The following are some of the figures, condensed:

Of the estimated total 745 million hp.

65 millions are in Europe.

160 millions are in North America.

94 millions are in South America.

236 millions are in Asia.

160 millions are in Africa.

30 millions are in Australia.

Compared to population South America leads with 5.25 hp. per inhabitant, followed by Australia, with 3.75 hp.; North America, 1.27 hp.; Africa, 1.14 hp.; Asia, 0.27 hp., and Europe, 0.13 hp. per inhabitant.

<sup>10</sup>Corse, Trans., A.I.M.E., vol. 60, 1919, p. 174.

# Importance of the Olefine Gases and Their Derivatives

## IV—Isopropanol (Isopropyl Alcohol)\*

**Commercial Preparation of Isopropanol From Propylene—Properties Depend to Some Extent Upon Method of Manufacture—Non-Potable Character Makes It an Important Industrial Alcohol—No Serious Physiological Effects—Interesting Possibilities for Use in Chemical Synthesis**

BY GEORGE O. CURME, JR., AND E. W. REID

IT IS interesting to note that within the past twelve months still another of the lower aliphatic alcohols has been removed from the list of materials available for pure science only and has taken its place among the commercial products open for development to our chemical industries. This alcohol is that one commonly known to chemists as isopropyl alcohol, but which will be termed isopropanol by the writers, as a more suitable common name.<sup>1</sup> The commercial introduction of isopropanol was first announced in this country late in 1920 by Ellis<sup>2</sup> as a product derived from the waste hydrocarbon gases of the Burton refining process. According to trade reports, it was also introduced industrially in Germany at about the same time. Further, the writers' company has been producing it on a commercial scale since early in the present year. As in all of these cases this product is being derived from gaseous propylene, and, moreover, is still relatively unknown to many industrialists, it finds a place among the other products of the new olefine gas industry which deserve to be better known by the chemical public.

The first description of isopropanol was given by Berthelot<sup>3</sup> in 1855, who prepared it by the absorption of propylene in sulphuric acid and the subsequent hydrolysis of the reaction product in water. Judging from his analyses, Berthelot was at first led to believe that this product was the *n*-propyl alcohol, and reported his discovery as such. At a later date Friedel<sup>4</sup> prepared this same product from acetone by reduction with sodium amalgam, and noted the identity of his product with that which Berthelot had prepared. It was not until the work of Kolbe,<sup>5</sup> however, that the identity of this material was cleared up and isopropanol was shown to be the first member of the series of secondary alcohols. Still another source of isopropanol has been reported—

namely, the fusel oil from the abnormal fermentation of grain,<sup>6</sup> in which it is said to occur to a limited extent. This source has been a matter of dispute and is of little importance from a production standpoint. A limited amount of isopropanol has always been available for scientific purposes, and this was made almost exclusively by the process of reduction of acetone with sodium<sup>7</sup> or with hydrogen.<sup>8</sup> Naturally from this latter source it would be impossible to prepare the material cheaply by any process, since acetone itself has always been much more expensive than commercial alcohol. Accordingly, until the technical development of the cheaper propylene process was accomplished, isopropanol could not sustain itself in competition with the other alcohols.

### PROPERTIES

The pure product, ( $C_3H_7OH$ ) is a colorless liquid with a pleasant alcoholic odor. It boils at 82.44 deg. C.<sup>9</sup> at 760 mm. and has<sup>10</sup> a density  $D_{40}^{20} = 0.7903$ . As is characteristic of the lower aliphatic alcohols above methanol, it forms a constant boiling mixture with water. It is in this form that it is being produced chiefly and may expect to have the widest application, just as is the case with grain alcohol. This constant boiling mixture contains 90.1 per cent isopropanol by volume or 87.9 per cent<sup>11</sup> by weight. It boils at 80.37 deg. C.<sup>12</sup> and has a density  $D_4 = 0.8336$ . An excellent table of specific gravities of isopropanol:water mixtures has been prepared by Lebo.<sup>13</sup> Some of the commercial grades, when prepared from gaseous mixtures containing olefines other than propylene, may contain certain amounts of ethyl alcohol—from ethylene—and also of secondary butyl alcohol—from butylene. This latter impurity is objectionable in some uses in that it gives a strong odor to the resulting product. Furthermore, there is the possibility of commercial grades being contaminated with an insoluble oil, a polymerized product of propylene, if not properly rectified in the production process. This also gives a distinctive odor to the material and is recognized by the turbidity given on dilution with water.

In the process of manufacture described by Ellis,<sup>14</sup> the gaseous mixture, containing propylene along with other ethylene and other olefine vapors, is first treated with sulphuric acid under conditions that absorb the higher olefine material, permitting the propylene and

A contribution from the Mellon Institute of Industrial Research of the University of Pittsburgh.

\*This article, the fourth of a series of five, treats of the most recent addition to the family of available industrial alcohols. It is now being produced in the development work carried out by the Carbide & Carbon Chemicals Corporation. Parts I, II and III were published Nov. 16, p. 907, Nov. 23, p. 957, and Nov. 30, p. 999, respectively.

<sup>1</sup>For commercial reasons it seems preferable to avoid the use of the word "alcohol" in designating a non-beverage material, as has been agreed by manufacturers and users of methanol and butanol. Accordingly, the writers propose the descriptive name isopropanol as a suitable designation for this new industrial product. The trade-name "petrohol" has already been adopted by the Standard Oil Co. of New Jersey for the commercial isopropanol which it has already placed upon the market. Since many other alcohols can equally well be made from petroleum and since isopropanol was first made from another source, this name does not seem well adapted for general use. Our industrial nomenclature will be much simplified to avoid such ambiguous terms, and to hold to names with a sounder chemical derivation.

<sup>2</sup>Ellis, *Oil, Paint and Drug Rep.*, vol. 98, No. 28, p. 23 (1920). See also *Chem. & Met. Eng.*, vol. 23, p. 1230, Dec. 22, 1920. U. S. Pats. 1,365,044; 1,365,046, and 1,365,048.

<sup>3</sup>Berthelot, *Ann. chim., phys.* (3), vol. 43, p. 399 (1855).

<sup>4</sup>Friedel, *Ann.*, vol. 124, p. 327 (1862).

<sup>5</sup>Kolbe, *Z. für chem.*, 1862, p. 687.

<sup>6</sup>Pringsheim, *Biochem. Z.*, vol. 10, p. 493; vol. 16, p. 243.

<sup>7</sup>Friedel, *loc. cit.*

<sup>8</sup>Sabatier and Senderens, *Compt. rend.*, vol. 137, p. 302 (1903).

<sup>9</sup>Young and Fortey, *J. Chem. Soc.*, vol. 81, p. 728 (1902).

<sup>10</sup>Thorpe, *J. Chem. Soc.*, vol. 71, p. 923 (1897).

<sup>11</sup>Lebo, *J. Am. Chem. Soc.*, vol. 43, p. 1005 (1921).

<sup>12</sup>Ellis, *loc. cit.*

ethylene to pass unabsorbed. By a second treatment the propylene only is absorbed in strong sulphuric acid and a solution of isopropyl sulphates in sulphuric acid is thus built up. By a subsequent hydrolysis of the reaction mixture with water, the sulphates are changed to the alcohol and the pure isopropanol is rectified to the constant boiling mixture. In the process in use by the writers certain of the above steps are avoided. From the sources mentioned in an earlier paper,<sup>11</sup> a gas containing none of the olefines but propylene is used for absorption in sulphuric acid, by a procedure that yields pure isopropanol directly on hydrolysis.

#### NON-POTABILITY AN IMPORTANT PROPERTY

In its general physical and solvent properties, isopropanol stands much closer to ethyl alcohol than does any other of the aliphatic alcohols, and consequently its applications may be expected to be in the nature of amplifying the supply of industrial alcohol available. It does possess the one great advantage that it is not a potable alcohol. Since this is true, it can be used in the pure form without need for any added denaturant, which is a material advantage in many applications. Indeed in most applications of isopropanol as a solvent or for other purely physical purposes it is so close to denatured alcohol in its properties that it may well be considered as a naturally denatured alcohol requiring no tax, no legal restrictions and no supervision.

By action of the Commissioner of Internal Revenue on June 15, 1921, isopropanol became a permissible substitute for acetone in the denaturing formulas 39, 39-A and 40. This is an official recognition of its non-potable character and at once offers a very considerable outlet for this new product in the production of denatured alcohol for uses where the strong odor of other denaturants is objectionable, such as in perfume manufacture, lotions for external application, etc.

#### PHYSIOLOGICAL EFFECTS

In the use of isopropanol there is not the poisonous effect noticeable that is so characteristic of methanol. It may be handled quite safely without any but the most common precautions against inhaling high concentrations of the vapor. The characteristic which renders it non-potable is quite similar to that of acetone, to which latter substance it is undoubtedly oxidized in the body on ingestion.<sup>12</sup> On account of this very favorable lack of serious physiological effects from handling, it seems most probable that in making shellacs, varnishes and other solutions, where the spontaneous evaporation of the solvent is an important item, the use of isopropanol will replace that of methanol, which in the past has caused many unfortunate accidents.

#### GERMICIDAL ACTION

Furthermore, the germicidal action of the higher alcohols has been claimed to be greater than that of ethyl alcohol. Therefore, after proper experimentation has determined the safe limits of application, it would seem to offer a wide field of usefulness in hospitals in many forms of surgical work, and also in dental practice, to provide a safe and accessible sterilization agent. Ethyl alcohol has been used for this in the past,

but unfortunately the present stringent regulations make it inaccessible to many who would desire to use such a material for strictly legitimate purposes.

#### CHEMICAL APPLICATIONS OFFER INTERESTING POSSIBILITIES

In strictly chemical applications the isopropanol does not compete so directly with the other alcohols, but offers a new material to work with, which will undoubtedly be found to have its own peculiar advantages and characteristics. Through this substance the isopropyl radical will become available for all kinds of synthetic work. At this time there is a very incomplete knowledge of the characteristics of isopropyl derivatives in the dyestuff, pharmaceutical, perfumery and other fine chemical industries. That the isopropyl derivatives will have a somewhat different color, solubility, stability, odor or physiological effect is assured, and to employ this knowledge, which is mostly yet to be gained, will require much research and many years for its fullest development. One large class of naturally occurring substances—namely, the terpenes—contains an isopropyl or modified isopropyl group. The possibility of producing any of these commercially by synthesis is now surely advanced through having a reliable source of this characteristic radical available.

Among the largest uses of all the other commercial alcohols is the preparation of their immediate derivatives which possess even a greater value—e.g., formaldehyde from methanol, ether from ethyl alcohol, amyl acetate from amyl alcohol, etc. The commercial value of the direct derivatives of isopropanol are as yet largely unknown, although that of acetone, the simplest and most direct one, is already fully established through its production from other sources. The commercial possibilities of isopropyl acetate, isopropyl chloride, isopropyl ether and the many other similar products, whose chemistry is already worked out in the older literature, are attractive indeed, and these materials are now waiting for the opportunity to be of service.

(Part V, dealing with ethylene chlorhydrin and ethylene oxide, will be published in a subsequent issue.)

#### Radium Production in Czechoslovakia

There is a large radium content in the uranium ore found at Jachymov, in Bohemia, near the frontiers of Saxony, reports Trade Commissioner Breed in *Commerce Reports*. Although the radium production in the United States is greater as to quantity, the ores of Jachymov are richer in quality. The known supply of radium in the Jachymov district will last for 20 years at the present rate of production and there are three large mines which are not yet prospected as to depth and in which the veins of ore widen as they are followed deeper.

The Jachymov mines passed in 1912 into the possession of the Austro-Hungarian Government. They have now become the property of the Czechoslovak Republic. The annual quantity of radium produced amounts to about two grams. The net profits to the government expected for the current year is about 3,500,000 crowns, which, of course, has less foreign exchange value than the pre-war profits. As the earnings from the radium mines of the republic are looked upon as a possible source of much profit to the government, projects are under way for electrifying the shafts and millhouses as well as enlarging and modernizing the entire plant.

<sup>11</sup>"The Technical Importance of the Olefine Gases and Their Derivatives—I." *CHEM. & MET. ENG.*, vol. 25, No. 20, Nov. 16, 1921.

<sup>12</sup>For a more precise description of the pharmacological action of alcohols see Francis and Fortescue-Brockdale, "The Chemical Basis of Pharmacology," 1908, pp. 91-92. Sollman, "A Manual of Pharmacology," 1918, also treats of this matter.

## Physiological and Histological Studies on Flayed Skins\*

Importance to Leather Manufacturer of a Knowledge of the Structure of Untanned Skins—Principal Divisions of the Corium—Elastic Fibers and Their Function—Experiments Showing the Value of These Observations in Studying the Mechanism of Bating

BY ALFRED SEYMOUR-JONES

THE leather industry and the veterinary profession are unfortunate in not possessing any literature dealing with the histology of animal skins. The published researches of Ranvier, Koelliker, Schaefer and others are devoted to the histology of the human skin, or part of it. Although their results are of material aid and value in enabling one to understand the physiology of animal skins, the variations in the physiological structure of these latter, according to the environment, breed, feed, habitat, etc., of the animal, are so great and marked that it is impossible to apply the work of Ranvier and others, except on general principles. This will at once be apparent if one compares the skins of such mammalia as the elephant, sheep, whale, seal, ox, rabbit, etc., or of reptiles, such as the alligator, lizard, etc.

While it is not proposed in this short paper to describe the histology of all, or even a modicum, of the skins entering into the art of leather manufacture, an endeavor will be made to cover some part of the ground by enunciating general principles which are the result of my researches, in the hope that by so doing it may be possible to throw some light on the causes for certain operations within the tannery.

The skin consists of two main divisions, the epidermis and the corium. The epidermis is entirely composed of keratins and their derivatives. The corium consists principally of collagen, keratins, elastin and fats.

The first act of the tanner is to remove the hair from the skin. In doing this the epidermis is removed as well, though it has not yet been practicable to remove entirely the epidermic products from within the corium, such as hair roots, hair follicles, sweat ducts and glands, etc.

The epidermis and hair being removed, there remains the corium, commonly called the "pelt." The tanner's next act is to remove the adhering flesh from the inner side, which is the *panniculus adiposus*, loose connective tissue joining the skin to the animal's body and which forms the flaying line.

The corium or pelt is now ready for examination. It is a most complex organization, possessing four distinctly different features, structural and chemical, of supreme interest to the producer of sound leather. The four divisions I shall term, pending the suggestion of more appropriate titles: (1) Grain membrane. (2) *Cutis minor*. (3) *Stratum adiposum*, or fatty layer. (4) *Cutis major*, or leather skin.

The grain membrane may be identified with the *membrana propria* observed by human skin physiologists, and is the same membrane which may be seen at the entrance to every opening into the body where the white

skin ends. Klein and Noble-Smith, in their "Atlas of Histology," refer to it as follows: "The boundary between the *stratum Malpighii* of the epidermis and the superficial part of the corium is represented by a fine but distinct membrane structure, basement membrane, which is very conspicuous in preparations stained with dyes. While in some instances it appears as a bright substance separating the deepest layer of epithelial cells from the corium, in others it takes the staining very readily, and, in fact, is made up of the individual cells which have undergone a chemical and morphological alteration. The basement membrane, then, is a direct product of the deepest layer of the epithelium, and its several constituent elements are comparable to the footplate of the deepest columnar cells of the stratified epithelium." That observation is a sound one.

The grain membrane varies in thickness and texture according to the breed of animal, varying, when dry, from 0.001 in. upward. It must be considered as much a part of the corium as it is of the epidermis, being partly keratinous and partly collagenous, and containing a comparatively large proportion of elastin. If a piece be boiled, very little gelatin is obtained; so little is it that the membrane undergoes very slight alteration. To the leather trade it is a valuable feature, and it is the aim of every manufacturer to maintain it intact and uninjured. It would appear to derive the bulk of its keratin from the roots of the basal epidermic cells. These cells are not cemented or glued to the grain membrane, but are attached by minute and innumerable fiber roots, to which the title "young keratin" may rightly be applied, to differentiate them from the harder keratin of the epidermis. When unhairing has been performed with milk of lime, only then these roots dissolve at the point of contact of the grain membrane and the epidermis, producing a glossy sheen called hyaline, or hyaline surface. Unfortunately it is seldom to be seen on the bellies of a skin, but is most marked on the back down the spinal area. Dyers of skins have been puzzled why the color is lighter on the back than on the bellies; this is due to the unequal distribution in thickness and density of the hyaline. Where and when the skin has been unhaired with pure sodium sulphide, or the limed skin has been treated to a bath of sulphide solution before bating, the keratinous hyaline is cleaned away. It is well known that sodium sulphide produces a coarser and rougher feel on the grain of the pelt compared with skins treated with lime alone. In this case the sulphide not only dissolves the hyaline but attacks the basal cell roots of young keratin penetrating the grain membrane.

The collagen content of the grain membrane would appear to be limited to the terminal white fibers of the *cutis minor* which tie themselves into the grain membrane. A large constituent appears to be elastin or its

\*Paper presented before the Division of Leather Chemistry at the sixty-second meeting of the American Chemical Society, New York City, Sept. 6 to 10, 1921. Published by permission of the American Chemical Society.

equivalent, and it is because of this that it requires suitable treatment to prepare it to receive any tannage.

The grain membrane is soft and thin in the soft fur or wool-bearing animals, but increases in thickness and harshness as the hairs become coarser and thicker. This latter fact especially applies to certain classes of goatskins. The epithelial pavement of the grain membrane is sometimes so thick as to form overlapping scales, giving a beard effect after unhairing. Beard is also caused by the coarse hairs either breaking off at their junction with the skin, or, when removed, they may have left behind, but broken off at their junction with the skin, the thick and horny hair follicle (epidermic). This and the broken off hair protrude sufficiently to cause the rough feel called "beard."

#### CUTIS MINOR

The *cutis minor* is the *cutis vera* of the human skin histologist. I suggest that the entire flayed skin or corium is the *cutis vera*, or true skin. The *cutis minor* is only from 5 to 20 per cent of the entire corium substance. But, small as it is, it is the most vital part of the whole, both pathologically and from the leather-making standpoint. The *cutis major* is radically different in every way and functions and forms a clearly separate layer. The *cutis minor* begins with the papillary layer and ends at the *stratum adiposum*, or fatty layer, in which the hair root bulbs repose and wherein are the sudoriferous glands with their ducts ascending through the *cutis minor* via the epidermis to the exterior. The *cutis minor* is composed of white collagenous fibers, yellow elastic fibers, *erector pili*, or hair-erecting muscles (which belong to the involuntary type), nerve fibers, sudoriferous ducts, blood capillaries and hairs with their accompanying epidermic follicles. It will be seen that it is a very complex organization.

#### STRATUM ADIPOSUM, OR FATTY LAYER

If the works of Koelliker and others are referred to and the drawings of vertical sections of skin examined, it will be seen that, perhaps inadvertently, the third layer has been called the *panniculus adiposus*. Obviously this is a mistake, as that layer is the loose connective tissue between the skin and the animal body, which enables the pelt to be flayed conveniently, and is commonly termed in the leather trade "the flesh," the substance which is removed from the inner side of the skin. Assuming that this is admitted, it becomes necessary to give a new title to this layer, and, as it is mainly composed of fat cells in groups, like bunches of grapes, it seems that *stratum adiposum* fits the case.

#### CUTIS MAJOR, OR LEATHER SKIN

The *cutis major* is to be identified with the *pars reticularis*, or leather skin. It is the major part of the whole, and is composed of large, thick white fibers, built up of numerous fibrils, traveling in every conceivable direction, crossing, criss-crossing, intertwining and sometimes splitting to become parts of other fibers. This apparently unreasonable arrangement appears to defy an explanation. It would seem that it is of set purpose. This layer is devoid of elastic fibers. It is collagenous, contains the usual blood vessels requisite for its nourishment and that of the regions beyond; likewise the nerve fibers pass through it. It is an almost inextensible layer, lying next to the body, growing as the beast grows; but it fails to reduce its area with the decline of the beast. Its functions would therefore appear to be

to act as a limiting and protecting coat for the body and a non-expansile base upon which the fatty layer and the *cutis minor* can rest.

Having rapidly reviewed the general structure of skin without going into minute details, the grain membrane and the *cutis minor* will be discussed in greater detail.

#### THE CAUSE OF GRAIN

Consider first the papillary layer lying immediately under and attached to the grain membrane. If a section be made of a raw skin in the hair, it will be seen that below the epidermis the skin shows a line of ridges and indentations. These represent depressions and elevations in the skin; they contain nerve endings and blood capillaries. If a section be made after unhairing, then they will probably have disappeared, or can be traced only with difficulty. This is due to the epidermis filling up the hollows or valleys; while appearing flat on the surface, the epidermis is thicker in the hollows and thinner on the apexes. The epidermis is a non-extensible quantity, holding the papillary layer intact, but, once the support has been removed, the grain membrane and papillary layer fall flat and expand in proportion. This layer calls for little comment from the leather standpoint, except to say that where the papillae exist, as in the case of goatskins, they are the cause of the pretty morocco grain. Their almost entire absence in ox, sheep and various other skins is the reason for their not "graining."

#### ELASTIC FIBERS AND THEIR FUNCTIONS

The *cutis minor* is very largely composed of white fiber bundles composed of fibrils, whose arrangement differs from that of their colleagues of the *cutis major* inasmuch as they are erect or nearly so. Except in certain instances they do not anastomose like those in the *cutis major*. If a section be examined after treatment with weak acid, it will be seen that they are in minute bundles, each bundle being choked by bands. These bands are elastic fibers. Descending from the grain membrane, they permeate the entire white fiber structure of the *cutis minor*, encircling the bundles, gathering the fibrils into bundles, sometimes dividing neighboring bundles, and attaching fibrils to other bundles. They are seen massed, encircling each hair follicle, and alongside are white fiber bundles which do not stand erect, but encircle the hair follicle with the elastic fibers keeping company. They spread all through the *cutis minor* in a marvelous network, terminating their activities only around the bases of the hair roots. According to their character, thick or thin, and their quantity, so is the firmness of the pelt.

It is interesting to note that the elastic fibers appear to possess selective capacity because they are never to be seen bunching the masses of blood capillaries or interfering with the *erector pili*, or any other part of the *cutis minor* organization except the white fibers. What is then their function? It naturally suggests itself. As the white fibrils are disposed more or less erect and are very densely packed together, they require something to maintain them in their erect attitude. This appears to be the function of the elastic fibers. They are under tension, and keep the whole of the *cutis minor* under tension, thus forming a cushion, keeping the hairs and their follicles in their correct positions and the groundwork clear for the other organs to function, giving free movement for the life-giving lymph sub-

stances. They enable the *cutis minor* to become a cushion to the *cutis major* and the animal body. Press the skin gently in life and it promptly recovers on removal of the pressure, due to elastic fiber action.

These statements are easy of proof. It will have been noted by tanners that the grain membrane is slightly larger after unhairing. Now split a skin through the *cutis minor*; this cuts through the elastic fibers, releasing them from tension. The white fibers then more or less collapse, the grain split expands several inches in area, but the flesh split remains exactly the same area. J. T. Wood, of Nottingham, at my request very kindly measured a number of split grains and their fleshes. He states: "The grains averaged 86 sq.ft. to the dozen, and the linings or fleshes, fully stretched, 71 sq.ft. to the dozen." But that is not the full area of the grains; they are still more or less bonded by the elastic fibers. Again Mr. Wood says: "When the grains are puered, they come out considerably more, because they can be stretched without springing back." Why do they not spring back after puering? The answer is the answer to the question, "Why do we puer?"

#### EXPERIMENTS ON THE MECHANISM OF BATING

Over 2 years ago I set out to find the answer by making a series of practical experiments. In order that there should be no question as to the accuracy of the experiments and results and having no available means to carry them out personally, Mr. Wood was asked if he would carry out certain experiments without indicating the object, though he, being an expert, quickly realized their aim.

First a sheepskin pelt was split and the grain and flesh were divided down the spine to make two halves of each. Grain A was delimed and puered with trypsin, because this enzyme acts freely on elastin, while grain B was simply delimed. Similar treatment was meted out to fleshes A and B. The deliming was carried out with weak acetic acid. The trypsin-treated grain, after tanning in sumac, was all such a leather should be—color, texture, etc., excellent. Its substance in the crust state was 0.008 in., CaO content 0.6 per cent.

The grain merely delimed, after sumac tanning, was of a brownish hue, with the grain tucked into fine nodules, texture harsh, lacking ideal qualities. In the dry crust condition its substance was 0.013 in., and CaO content 0.9 per cent.

The lime content is a negligible quantity and does not offer the true explanation for the great difference. The trypsinized grain shows a loss in substance, the difference in the two grains being approximately 50 per cent. Something has been dissolved out. As trypsin attacks elastin vigorously, it may be assumed that the elastic fibers have undergone a change, especially as the grain membrane is so soft and flexible.

The trypsinized flesh on casual examination does not appear to vary in any marked particulars from the acid delimed flesh, but on testing equivalent parts for substance, it was seen that the trypsinized flesh was thicker and also weighed more. CaO contents were 0.72 and 0.82 per cent respectively. On analysis the following results were obtained:

	Flesh A Per Cent	Flesh B Per Cent
Moisture.....	14	14
Mineral ash.....	1.6	1.9
Hide substance.....	43.1	45.6
Tanning matter.....	41.3	38.5

Here lies the explanation. The trypsinized flesh has lost some of its hide substance (probably mucin), which has been replaced with the heavier weighing tanning substance filling up the waste areas opened up. On washing out the free tan, the flesh fell in substance to lower than the delimed flesh. While trypsin attacks elastin preferentially, it is quite capable of attacking the young collagen substance or mucin, but does not digest collagen unless previously suitably treated.

The trypsinized flesh is slightly coarser of fiber than the delimed. This is to be expected. What the experiment does prove is that it is not at all necessary to puer the flesh unless loss of hide substance is desired. As a chamois-making proposition, or for making imitation suèdes, the delimed flesh is far superior. As it appeared to be unwise to puer the flesh when it is desired to retain as much substance as possible, a further experiment was undertaken to prove whether it was possible and practicable in a whole skin to puer the grain membrane and *cutis minor* only. Mr. Wood, at my request, anointed a sheep pelt, after acid deliming, with a trypsin paste on the grain membrane side only. After laying out flat on the floor until it was considered "down," it was scudded and sent direct into sumac tan. The result was a perfect full-substanced tanned skin of beautiful color. There was no loss of *cutis major* substance. The skin was degreased with naphtha after tanning. It will be noted that no bran drench was employed.

The last experiment was repeated, this time on a light medium substance goatskin, subsequently chrome tanned and finished as glazed kid. Here the grain is silky and mellow without the least evidence of internal looseness, texture excellent, and substance has been maintained. The only loss of substance in either the sheepskin or the goatskin occurs in the collapse of the *cutis minor* structure due to the loss of its binding fibers.

#### ELASTIN REMOVED BY BATING WITH TRYPSIN

So far as these experiments go, they illustrate the fact that it is the grain membrane and the *cutis minor* alone which require puering or bating, and it is wise to confine the bating action to that part of the skin alone. But they are not conclusive as to what it is that has "collapsed" under the treatment. To test this it is necessary to make skin sections at different stages of the process of bating. It must be pointed out that the method of testing skin sections as to the presence of cells, collagenous fibers, yellow elastic fibers, etc., is by applying different staining materials. For example, collagen has a special affinity for acid fuchsin and water blue, while elastin has a strong affinity for acid orcein. Sections made before and after bating clearly showed that the elastin had disappeared; at least, if it was present, it had so altered its character as to be void of elastin proper and unresponsive to acid orcein tests.

Most interesting confirmatory evidence has come from the laboratory of R. F. Gallun & Sons of Milwaukee, in a paper by J. A. Wilson, entitled "The Mechanism of Bating." This paper was accompanied by excellent photomicrographs showing sections of calfskin untreated with trypsin, and after 6, 20 and 24 hours bating with trypsin. The unbated section exhibits the elastic fibers massed. The three successive sections, varying as to time of treatment by trypsin, show the gradual disappearance of the elastic fibers until finally none are to be

seen. This then furnishes practically conclusive evidence of the part played by trypsin on the elastic fibers.

#### ACTION OF OTHER BATING METHODS

But trypsin or its equivalent is not the only material employed in bating. Our forefathers employed what has been called the "river process," the skins being left in a soft water running stream until they were soft and flaccid. Exactly what happened is not at all clear. Then the bran drench alone is used as a bate with great success. Here there can be no question of the presence of trypsin, it being entirely composed of fermentative acids. This acid process is the same as the old ooze employed by tanners in bygone days, and the same as the sour suspenders of modern tannery practice and the process invented by Dr. MacBride of Dublin over a hundred years ago in using vitrol to hasten tanning. The pickled sheepskins from New Zealand and Australia cannot be said to receive any bate prior to pickling, and yet they tan soft grains, like all pickled skins will. The acid bate is an alternative to trypsin. Pfeuffer, Mall and others have pointed out that acids and alkalis break up the elastin into globules, and eventually dissolve it. This implies inverting the elastic tissues along the line of their growth. Ranvier has shown that the development of elastic tissue is by deposition of fine granules of elastin, forming themselves into monoliform rows of fibers; these are inclosed in a sheath, the whole containing the substance called "elastin." The granules or cells grow or are converted into what we know as elastic tissue. The acid or alkali process mentioned causes the process to invert, with the consequential release of the "elastin" and the grain membrane is capable of receiving tanning.

#### OPPORTUNITIES FOR FURTHER RESEARCH

This only touches on the fringe of one of the most perplexing yet important subjects of the leather industry. Yet enough has been said to make it worth while for the subject to become a valuable line of research. No process of leather making is more disgusting, or attended with more unpleasant consequences, or causes more unsound leather to be made and money lost, than the bating process. No money is spared to tan a skin soundly, but such is wasted when the very foundation is wrong, and I submit that a case has been made out for more extended research into the foundation processes of the leather industry.

It has been impossible to describe the structure of all the varied skins entering into the art of leather manufacture, or to speak of its chemical side.\* But sufficient has been said to illustrate the assistance which a proper use and appreciation of the microscope can be in elucidating the problems, amounting to mysteries until they are solved, which surround leather production. The field for research is larger in this than in any other industry, and the rewards from patient successful research cannot be estimated in cash values. The golden key to the mysteries lies hidden, waiting the advent of the finder, and he who will devote himself patiently to research, however long it may take, will discover that key fitted with suitable wards ready to open unto him his inheritance. Successful research is the highest rewarded effort in this life.

Wrexham, North Wales.

\*The chemical metabolism within the skin organization, differing as each successive layer does from its neighbor, yet called under the one term, collagen (glue producing), is an almost untrodden field for research.

## Legal Notes

BY WELLINGTON GUSTIN

#### The Gaulin Patent, Claim 7, Held Valid, but Not Infringed

In the recent case of Marston-Gaulin Manufacturing Co. vs. Wright-Ziegler Co. and others, the Federal Circuit Court of Appeals, First Circuit, held that the Gaulin patent No. 756,953, claim 7, for an apparatus for intimately mixing liquids, was valid but not infringed. (271 Fed., 391.)

The patent was issued to August Gaulin for an "improved apparatus for intimately mixing milk and other liquids more or less resembling it by means of the action produced by the passage of liquids more or less heterogeneous under considerable pressure through very small orifices." The claim in issue was No. 7 and follows: "In a machine of the class described, an element having a re-entrant conical surface, a complementary conical element to fit the same, and means to force milk between them, substantially as described."

Defendant contended that the patent was invalid and non-infringed. In two previous suits on the patent it had been held valid on another claim, hence the court assumed that the approved apparatus disclosed inventive thought and was patentable.

The plaintiff contended that although a re-entrant conical valve is old, the combination is new and the claim valid, even though it does not state whether the surfaces of the conical valve, when in operation, yield one to the other, rendering the orifice of the valve variable, or whether the surfaces are rigidly fixed, rendering the orifice invariable, and that the plaintiff is at liberty, for the purpose of making the combination workable, to employ such means as may be disclosed in the specification for holding and adjusting the surfaces, or any suitable means that is common.

#### CLAIM OF THE DEFENSE

The defense was that if the claim be valid its language must be interpreted to mean that the conical surfaces are yielding and thus afford a variable orifice; that if the surfaces are non-yielding so that the orifice, when the device is in operation, is fixed or invariable, as the plaintiff said the claim should be interpreted, the claim would not be based upon the invention which Gaulin conceived, but upon a device the principle of which he disclaimed in his specification.

#### DECISION OF THE COURT

However, the majority opinion of the court held that the claim was valid; that read in the light of the specification, the language of the claim, where the conical surfaces are spoken of and are required to fit one with another, and between which the liquid is to be "forced, substantially as described," means that the liquid is to be forced between surfaces which fit closely one to the other and permit the liquid to be forced through because of their yielding quality.

As thus construed, the defendants do not infringe the claim, for the conical surfaces of the defendants' device are not yielding, but fixed, and the orifice is invariable, said the court.

## Note on Mushet Steel

BY A. H. D'ARCAMBAL

Metallurgist; Pratt & Whitney Co., Hartford, Conn.

**WE RECENTLY** conducted some tests on a  $1\frac{1}{4}$  x  $\frac{1}{4}$ -in. bar of Mushet steel received by the Pratt & Whitney Co. about 30 years ago. The analysis of this material was as follows:

	Per Cent		Per Cent
Carbon.....	2.38	Chromium.....	1.12
Manganese.....	1.73	Tungsten.....	4.80
Silicon.....	1.15		

The chromium content is considerably higher and the tungsten content slightly lower than the Mushet steel used by Taylor in his classical experiments. Brinell hardness on this material as received was 512, somewhat high according to present ideas, but as tools were always forged from this material, this hardness was not detrimental. Referring to Fig. 1, the micrograph of the material as received shows large plates of carbide imbedded in the martensitic-troostitic matrix.

Three small pieces were cut from the bar, one quenched from 1,500 deg. F. (816 deg. C.) into oil (the temperature usually given Mushet steel), the second piece quenched from 1,900 deg. F. (1,038 deg. C.) into oil, and the third piece from 2,200 deg. F. (1,204 deg. C.) into oil. After hardness tests and micrographs were made of each of these pieces, they were drawn to 1,000 deg. F. (538 deg. C.), air-cooled, again tested for hardness, and photographed. Hardness results were:

Tempera- Quenching, Deg. F.	tur., Deg. C.	Drawing Medium	Temp., Deg. F.	Sclero- scope Deg. C.	Brinell	Micro- structure
1,500	816	Oil	1,000	538	95	652 Fig. 2
1,500	816	Oil	1,000	538	80	512 Fig. 3
1,900	1,038	Oil	1,000	538	53	364 Fig. 4
1,900	1,038	Oil	1,000	538	87	600 Fig. 5
2,200	1,204	Oil	1,000	538	50	364 Fig. 6
*2,200	1,204	Oil	1,000	538	95	652 Fig. 7

\* The first piece given this treatment broke into several small pieces while being tested for hardness and a new piece had to be given the same treatment.

Figs. 2 to 7, containing these micrographs, show that the 1,500 deg. F. (816 deg. C.) quench gave a martensitic structure, most of the carbides being in the free state. Drawing at 1,000 deg. F. (538 deg. C.) produced a martensitic-troostitic structure with a corresponding decrease in hardness.

The 1,900 deg. F. (1,038 deg. C.) treatment produced an austenitic structure, containing a little martensite. This higher temperature also dissolved more carbides. Drawing to 1,000 deg. F. (538 deg. C.) gave a martensitic structure, greatly increasing the hardness.

<sup>1</sup>C, 2.40; Mn, 1.90; Si, 0.71; Cr, 0.49; W, 5.62.

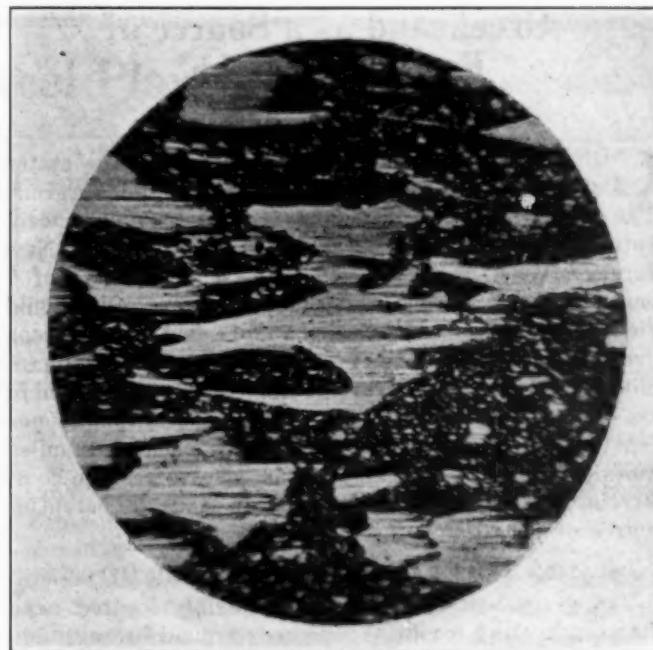
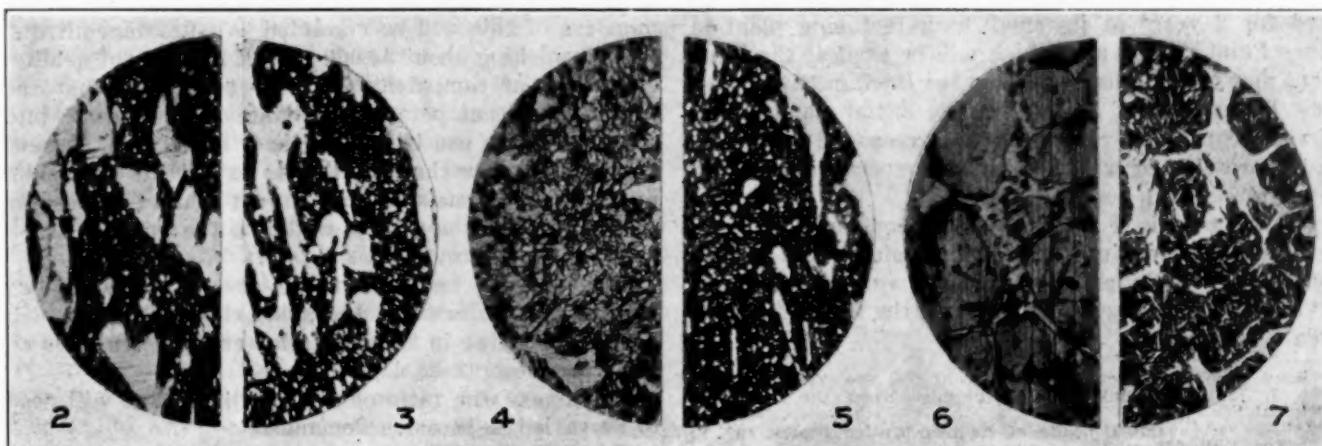


FIG. 1. BAR AS RECEIVED.  $\times 500$ .  
ETCHED 3 MIN. WITH NITAL

We attempted to quench the remaining piece from 2,300 deg. F. (1,260 deg. C.), but due to the analysis of this material, principally the high percentage of carbon present, the material began to soften at 2,200 deg. F. (1,204 deg. C.) and was therefore quenched at this temperature. The micrograph shows the material to be overheated, liquefaction and resolidification of the carbides at the grain boundaries taking place. The structure is austenitic and entirely non-magnetic. Drawing to 1,000 deg. F. (538 deg. C.) gives a martensitic structure, the large grain boundaries remaining unchanged, but this high drawing temperature made the steel so brittle it broke into several pieces under the Brinell ball. The scleroscope and Brinell readings nearly doubled after this high draw.

It would appear from the results obtained in these experiments that the best treatment for this steel would be to quench from 1,900 to 2,000 deg. F. (1,038 to 1,093 deg. C.) and draw back to from 1,000 to 1,050 deg. F. (538 to 566 deg. C.). Taylor in his experiments showed that Mushet steel did not respond to the Taylor-White treatment in as high a degree as some of the other self-hardening steels, due to the low chromium content of the Mushet material.



FIGS. 2 TO 7. MUSHET STEEL AFTER VARIOUS HEAT TREATMENTS NOTED IN THE TABLE.  $\times 350$ .  
ETCHED 3 MIN. WITH NITAL

## Greensand as a Source of Fertilizer Potash\*

BY R. NORRIS SHREVE

**G**REENSAND occurs very extensively in the states of New Jersey, Delaware, Maryland and Virginia. The commercial beds carrying from 5 to 7.5 per cent potash, however, are chiefly within the state of New Jersey. When it is realized that "a 20-ft. bed (of 7 per cent K<sub>2</sub>O material) that covers a square mile should yield 1,500,000 tons of potash; a 20-ft. bed of 5 per cent greensand should yield 1,000,000 tons to the square mile;" and when it is further remembered that "there are many square miles of greensand containing 7 per cent of potash and perhaps hundreds of square miles containing 4 or 5 per cent," it is easy to see the commercial possibility of greensand as a large potential source of potash for fertilizer or other use.

### LOCATION AND CHARACTER OF GREENSAND DEPOSITS

The greensand deposits are accessibly located near the potash-using localities; the beds are cut by railroads in a number of places, and they are also accessible to water transportation. Furthermore, the greensand is near the surface, so that cheap methods of mining by steam shovel or dredging can be employed. Mineralogically greensand is a mixture of the potash-carrying glauconite with more or less sand, shells, etc. The separation can be made magnetically, and this scheme is practical on a large scale to concentrate the beds with lower potash percentages up to 6.5 to 7 per cent potash.

Commercial beds of greensand contain around 7 per cent of potash, 50 per cent of silica, 18 to 23 per cent of iron oxides (as Fe<sub>2</sub>O<sub>3</sub>), 7.5 to 10 per cent of alumina, 3 to 7.5 per cent of magnesia and small amounts of lime, soda, sulphuric acid and phosphoric acid. Often the soda is practically absent, and chlorine is always very low.

Forty and more years ago the greensand was mined very extensively by the local farmers of New Jersey and spread on their fields with very satisfactory results for that time. However, the potash and phosphoric acid in the greensand are so slowly available that this practice was not economical in competition with the more concentrated and more readily available fertilizers later introduced.

A number of potassium compounds suitable for fertilizer use can be made from greensand, and among these potassium nitrate offers the most advantages.

The process that the Eastern Potash Corporation has used for 2 years at its small manufacturing plant at Jones Point, N. Y., and which will be used at the large plant now under construction on the Raritan River, near New Brunswick, N. J., involves the initial manufacture of caustic potash by treating the greensand with lime in the presence of water and at a temperature of about 470 deg. F. for 1 hour.

Caustic potash is a very reactive compound and can be easily changed into various potassium salts and in such a way as to preserve also the very valuable hydroxyl part of the caustic potash—in the form of caustic soda for example.\*

\*Read before the Fertilizer Division at the New York meeting, Sept. 7, 1921, and published by permission of the American Chemical Society.

<sup>1</sup>Ashley, Greensand Deposits of Eastern United States. U. S. Geol. Surv. Bull. 660, p. 28.

<sup>2</sup>Ibid., p. 28.

<sup>3</sup>J. Ind. Eng. Chem., vol. 13, p. 695 (1921).

The reaction was initially carried out as follows: 1302 g. of a commercial caustic potash from greensand, analyzing 42.6 per cent KOH, was placed in an iron kettle and 912 g. of commercial nitrate of soda, analyzing 1.65 per cent KNO<sub>3</sub> and 94.2 per cent NaNO<sub>3</sub>, was introduced. This was sufficient to produce theoretically 1,000 g. of potassium nitrate.

The reaction was carried out by heating at 105 to 110 deg. C. for 30 minutes, and then allowing to cool. The potassium nitrate was separated and washed with alcohol, weighed and analyzed:

Dry weight of potassium nitrate recovered, grams.....	957
Weight of mother liquor, caustic soda (37.5 deg. Bé.), grams.....	90
Weight of alcohol wash, grams.....	242

### Analysis of Potassium Nitrate

KNO <sub>3</sub> , per cent.....	97.3
NaOH, per cent.....	0.8
Na <sub>2</sub> CO <sub>3</sub> , per cent.....	2.0
NaCl, per cent.....	0.1

The recovery of potassium nitrate was 91.6 per cent on this first crop, when the 15 g. of potassium nitrate contained in the original nitrate of soda is subtracted from the weight obtained.

A few more per cent of potassium nitrate is recovered from the mother liquors by subsequent concentration and crystallization. The final mother liquor is 50 deg. Bé. caustic soda carrying about 1½ to 2 per cent K<sub>2</sub>O and about twice this per cent of N<sub>2</sub>O<sub>5</sub>. During the process of solidification of this caustic soda the N<sub>2</sub>O<sub>5</sub> can be largely removed, resulting in a caustic soda of commercial quality.

On a large scale, using centrifuges and water washing, a potassium nitrate of from 95 to 97 per cent purity is easily obtained without recrystallization, and this potash salt will be offered to the fertilizer trade.

### POTASSIUM NITRATE DIRECT FROM GREENSAND

As the process will actually be carried out, the sodium nitrate will be added to the digestion mixture of greensand, lime and water, because of the very valuable accelerating action of the nitrate upon the decomposing action of lime on the greensand,<sup>4</sup> wherein the yield of converted potash is increased from 60 to about 80 per cent.

Upon concentration of the caustic liquors, the potassium nitrate crystallizes out, leaving the caustic soda. For every 100 tons of potassium nitrate manufactured there will be obtained about 40 tons of caustic soda of commercial grade. Consequently the importance of the caustic soda production in cheapening the cost of the potash compound is very apparent.

The plant under construction will produce about 20,000 tons of K<sub>2</sub>O per year, and approximately three-quarters of this will be marketed as potassium nitrate, thus furnishing about 34,000 tons of 95 per cent quality.

Opinion of competent fertilizer experts is that the only reason that potassium nitrate has not come into more extensive use in the fertilizer trade is on account of its price. As the intention is to sell the potassium nitrate on the basis of the current market prices for the potash and the nitrate contents, the past objection will no longer prevail.

Furthermore, because of the concentration of two fertilizer ingredients in the same chemical, there will be a large saving in transportation charges, which is an important item these days.

To be sure, the ratio of nitrogen to potash will need to be varied as occasion demands.

New York City.

<sup>4</sup>J. Ind. Eng. Chem., vol. 13, p. 693 (1921).

## Electric Iron and Steel Plant for Brazil

**This Unique Installation, the First of Its Kind, Includes Two Swedish Type Pig-Iron Furnaces, Two Bessemer Converters, a Ludlum Steel Furnace and Two Merchant Mills, All Driven by Electric Power and Heated by Electric Energy**

BY N. A. V. PAULSSON  
Consulting Engineer, Corning & Co.

**W**HAT is thought to be the first all-electrical plant making steel from iron ore has been designed by Corning & Co., Inc., of Albany, N. Y., and is now under construction in Brazil. It also bears the distinction of being the first complete steel plant in Brazil—a country which has been credited with having the greatest reserves of iron ore in the world. At present there are a few very small, primitive blast furnaces making charcoal iron, but their combined output is not more than 40 tons of pig iron per day. The State of São Paulo also has a steel foundry, with two small electric furnaces melting scrap, and a small rolling mill where faggoted scrap is rolled into bar iron. Consequently the new plant is the first step toward supplying a domestic market which in 1919 imported 40,000 tons of merchant bar and sheets and 135,000 tons of wire, tin plate, rails and pipe.

### TO ABSORB SURPLUS POWER BETWEEN SEASONS

Electric steel making in Brazil will be the result of an attempt to utilize electrical generating capacity during the "off-peak" season. A power company called the Empreza Forca e Luz de Ribeirão Preto had built some hydro-electric plants and gradually spread out a network of transmission lines serving a large number of coffee plantations. Each of these required in the neighborhood of 100 hp. to drive its machinery for cleaning the hulls from the coffee bean, but a large part of this demand existed only during June, July and August, and unfortunately these months are the dry season, when there is a minimum stream flow. During the remainder of the year a considerable amount of developed and an enormous amount of undeveloped horsepower was available for use, but no user appeared. Consequently the power company set about a search for some industry—any industry—which would have a large consumptive demand for electricity, which could run at a low rate, or be entirely shut down for two or three months each year, which would increase the population of the locality and which would turn out a product readily salable in domestic or foreign markets. Steel manufacture seemed best to meet these requirements, so an affiliated company, the Cia Electro Metallurgica Brasileira, was organized to construct and operate such a works at Ribeirão Preto, a small town near the center of the power network.

Ribeirão Preto, as can be seen from the map, Fig. 1, is in the northern part of the State of São Paulo, about 250 miles inland from Santos. Entering the latter port, one boards the English-owned São Paulo Railway Co., of broad-gage and excellent equipment, which climbs up the steep border of the inland plateau through São Paulo to the rail-center at Campinas. From here inland extends the Cia Mogiana de Estrado

do Ferro, of 1-meter gage, through rolling country, well developed, with good communications and almost exclusively given over to coffee plantations. Ribeirão Preto is in the midst of such a region, at 1,500 ft. elevation. Ore will come about 75 miles from an iron mountain called Morro do Ferro, just over the line in the State of Minas Geraes. Eventually the steel company will own a direct road between mine and smelter, but at present the ore will be brought to the plant over narrow-gage (60 cm.) English-owned road connecting with the main line at São Simão.

Morro do Ferro is a huge deposit of hematite, covered with broken ore—canga, so called—which analyzes 65 to 67 per cent iron, the equivalent of 93 to 96 per cent  $Fe_2O_3$ . It is therefore of unusually high tenor. One sample analyzed in this country showed  $Fe_2O_3$ , 90.9; FeO, 2.9; MnO, 0.54; SiO<sub>2</sub>, 5.4; S, 0.00; P, 0.022. Pig iron reduced from a sample shipment to the United States, using a pit furnace and charcoal, analyzed Fe, 95.3; Si, 0.06; P, 0.02, and C, 4.5. A considerable tonnage of this loose ore may be had for the trouble

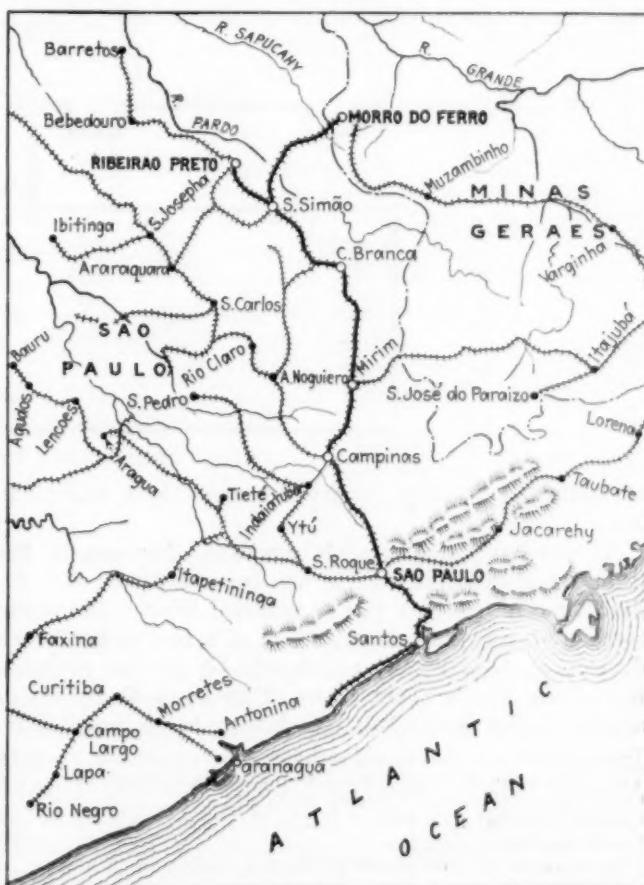


FIG. 1. MAP OF TERRITORY SURROUNDING SANTOS

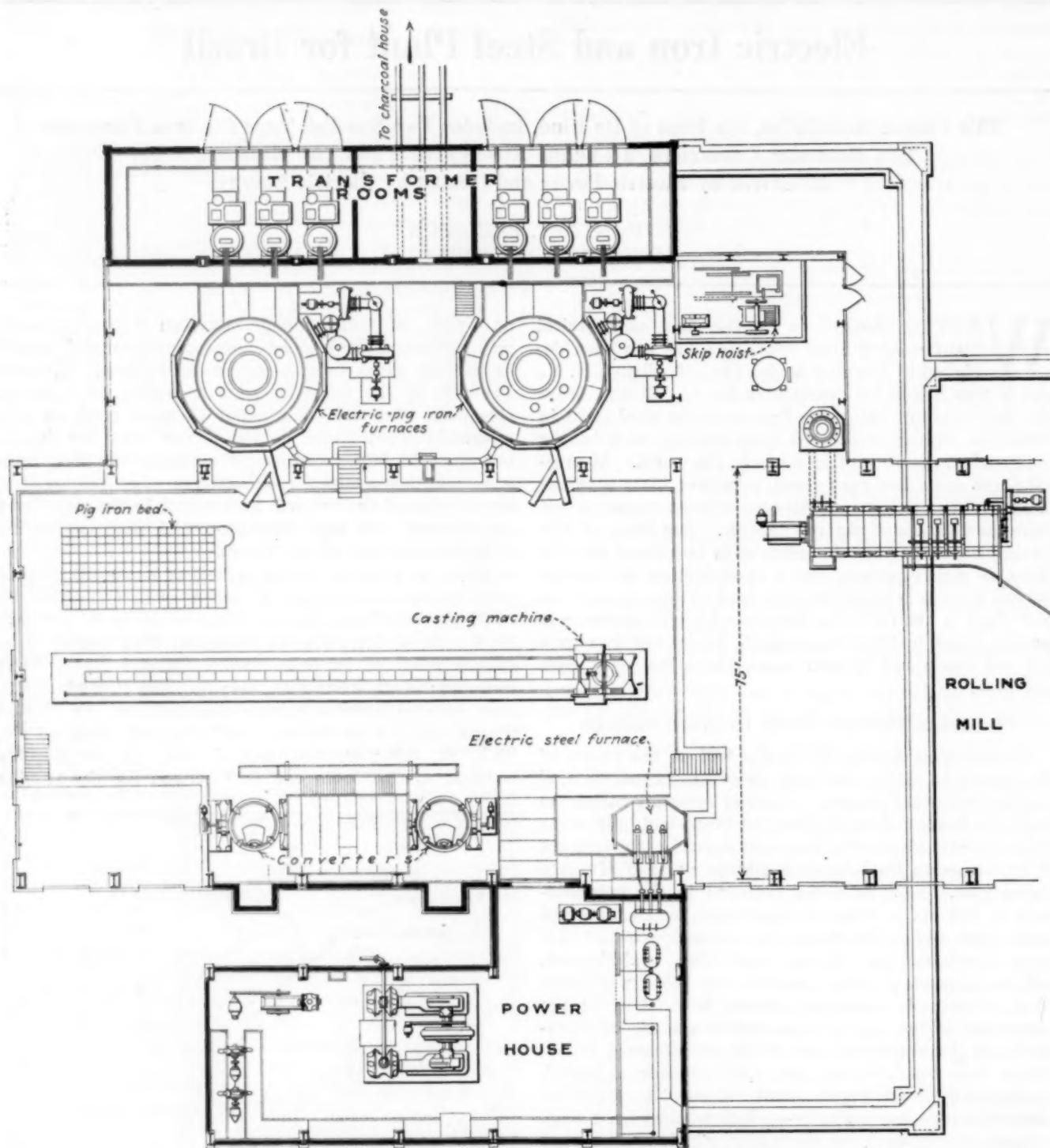


FIG. 2. GROUND PLAN OF IRON AND STEEL PLANT

of loading it on cars; quarrying operations will begin later.

At present 5,000 kva. is available for use in the iron and steel plant, and it has been designed for this limiting condition, as will be detailed later. The power company has started construction of a new power house, developing 12,000 kva., which will be for the exclusive use of the smelter; the plans (Figs. 2 to 4) permit of any extension demanded. Machinery to be installed is:

Two Swedish type furnaces, 1 standby, kva.....	3,000
Two 6-ton bessemer converters (blowing engine for one), kva.....	700
One 6-ton Ludlum steel furnace, max., kva.....	1,500
One 16-in. rolling mill, kva.....	500
One 10-in. rolling mill, kva.....	500
Miscellaneous 220-volt power for motors, cranes, shops and lighting, kva.....	400
	6,600

This tabulation shows that it will not be possible to operate all units simultaneously—indeed, the plant is designed having balanced operation not so much in mind as to be the nucleus of a larger plant, and therefore it contains a series of units large enough to operate with undoubtedly success and economy. Thus, experience has shown that the pig-iron furnaces may be tapped advantageously four or five times a day, each tap yielding about 6 tons of iron. This is transferred immediately to the bessemer converter and blown to steel, an operation requiring not more than 15 to 20 minutes on the iron smelted in 5 hours. Normally the steel will be cast direct into ingots, but if it needs "doctoring" in any way, it will be transferred molten to the Ludlum steel furnace, an appropriate slag made up, deoxidizers and carburizers added, and then it will be cast into

ingots. Cold, low-silicon pig will also be reheated in the Ludlum furnace, and necessary ferrosilicon added before the blow. Such duty on the steel furnace might require 2 hours at most, and would occur but infrequently. Consequently there remains an ample period of time, even during the day shift, when the mills can dispose of the 30 tons of steel produced in the preceding 24 hours without drawing any power when the steel-making department is also making its demands.

#### ELECTRIC PIG-IRON FURNACE

Exclusive South American rights for the Swedish type of electric pig-iron furnaces have been bought by the Cia Electro Metallurgica Brasileira. Two of them are now being installed (Figs. 2 and 3), each with electrical transformers and complete in all respects. As noted above, only one can be operated, however, until the new power house is completed.

This furnace has been discussed from many viewpoints in the technical press and especially in America by CHEMICAL & METALLURGICAL ENGINEERING, so there is no need of describing the details further, except noting such changes as it has been thought desirable to make to conform to the conditions existing in Brazil. An excellent drawing of the furnace was published in this journal, March 9, 1921, vol. 24, p. 431, by Baron de Geer, which may be referred to.

It has been thought desirable to decrease the diameter and height of the shaft (which, by the way, is hung from the building), because the charcoal avail-

in the open market—in the almost total absence of coal, it is a staple commodity. As circumstances warrant, the company will plant its own eucalyptus forests for a source of fuel. Such is a common practice of the Brazilian railways; eucalyptus culture is quite well understood. The tree matures in 5 to 6 years, having a trunk at least 6 in. in diameter.

#### ELECTRICAL FEATURES

Current is received at 30,000 volts, 50 cycles, three phase, and will be transformed outdoors to 6,000 volts, whence it is taken by lead-covered underground cables

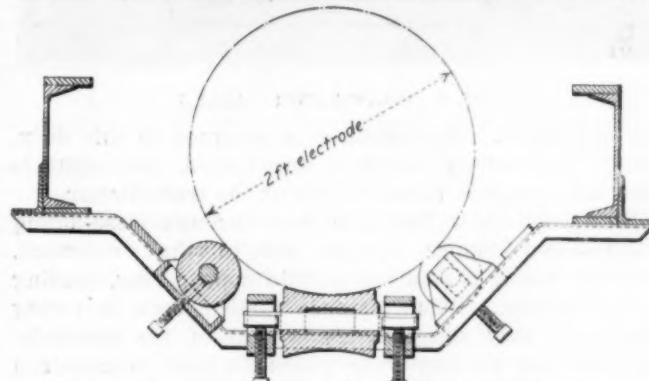


FIG. 4. CROSS-SECTION OF ELECTRODE CRADLE

to the substation adjacent to the mill building. Each pig-iron furnace has three 1,500-kva. water-cooled General Electric transformers, especially built for this service, whose secondary will deliver any voltage from 60 to 120 volts—smooth curve regulation. Each furnace has six 24-in. carbon electrodes. Adjacent electrodes are connected with the same phase; or, expressed in another way, denoting phases by A, B and C and reading around the circle, the electrodes are connected thus: A, A, B, B, C, C. Such a layout makes for very

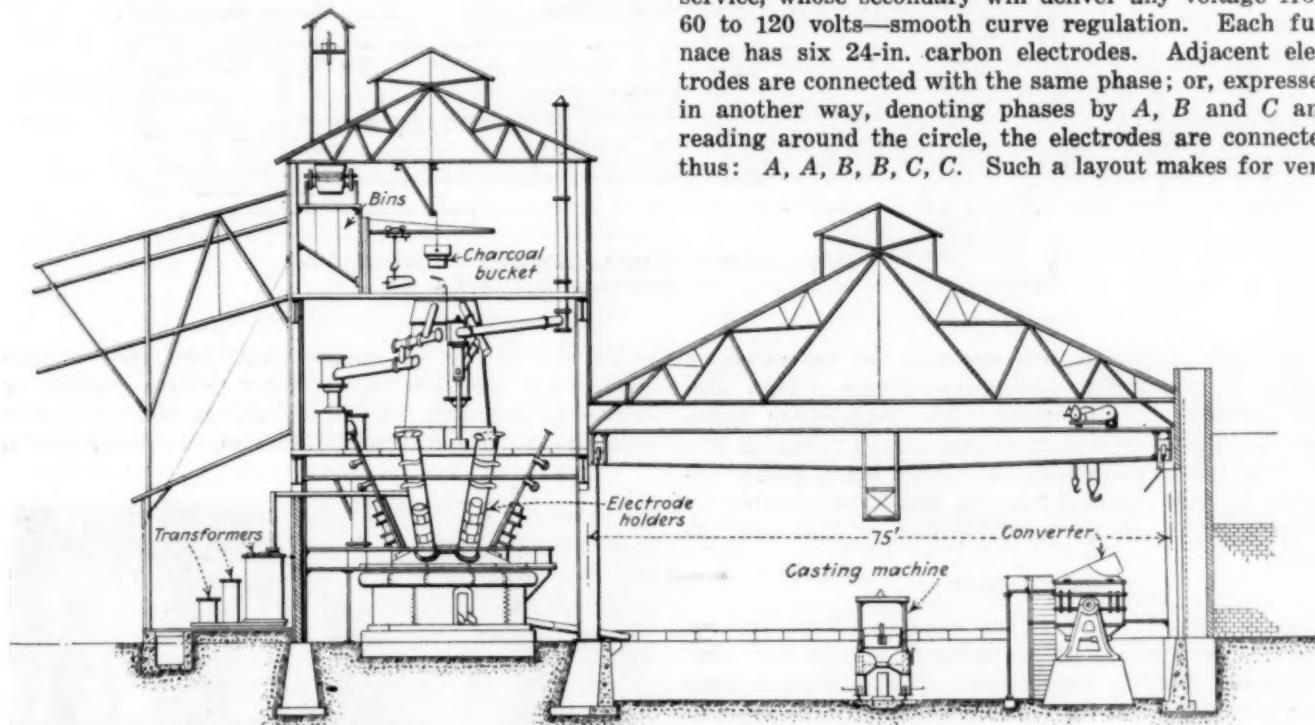


FIG. 3. ELEVATION OF STEEL-MAKING DEPARTMENT

able in Brazil is very much denser than that made from the northern conifers, and the charge is consequently less bulky. Brazilian charcoal weighs 15 lb. per cu.ft., while that name in Sweden weighs but 9 lb. Its electrical resistance and other physical characteristics are not so much different as to cause the designers to expect a repetition of the troubles experienced when coke was first used in place of charcoal.<sup>1</sup> Charcoal will be bought

easy busbar connections, offering ample opportunity for interlacing between transformer and electrode, and produces a good power factor.<sup>2</sup>

An ample equipment in electrical meters is provided for each electrode. Since the electrodes are immersed in the hot granular charge and are fed into the furnace only at intervals as they are consumed at the lower end, control is had by adjusting the voltage impressed on

<sup>1</sup>"Electric Smelting of Iron Ore With Coke," by Georg Stig, CHEM. & MET. ENG., vol. 23, p. 29, July 7, 1920.

<sup>2</sup>"Manufacture of Electric Pig Iron in Sweden," by J. A. Leffler, *Teknisk Tidskrift*, April 27, 1921.

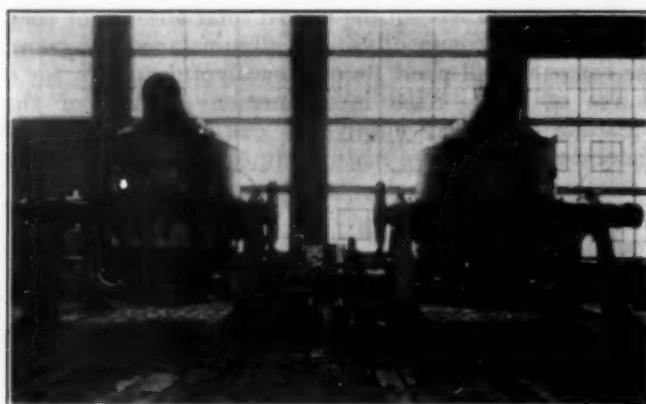


FIG. 5. CONVERTER SHELLS

any one phase. One operator is assigned to this duty, and if the current becomes unbalanced, the input is adjusted by appropriate changes at the transformer.

Electrodes enter the bosh roof through close-fitting water-cooled copper sleeves, set in the brickwork. Directly above is clamped a solid copper ring, leading in the current. Some distance further back is a ring which not only supports the weight of the electrode, but has ears on each side which fit into channel-iron guides, 16 ft. long and supported by the building. Hung

Charcoal is transported from the charcoal house to the furnace top in 250-lb. buckets, carried on an aerial tramway.

About sixty charges per day of approximately 1 ton each will be made. A single bell is sufficient for such infrequent operation. A small quantity of powdered ore is thrown into the hopper previous to the regular charge, thereby forming a seal which prevents gas escaping and guards against gas poisoning.

Since the steel is to be made in bessemers, it is necessary that it contain at least 0.75 to 1.00 per cent silicon to furnish the requisite heat during conversion. It is also desirable to blow iron containing 1.5 to 2.0 per cent manganese, so there may be some residual manganese. To provide the latter an appropriate amount of manganese ore from some Brazilian source will be a portion of the charge. It is well known that furnace irregularities make it impossible to tap hot high-silicon iron at all times; consequently the Ludlum furnace is expected to prove most useful in increasing the temperature and adjusting the chemical composition of off-runs of iron before conversion.

#### STEEL MAKING

Two 6-ton bessemer converters shown in Fig. 5, built by the M. H. Treadwell Co., will be installed, one of

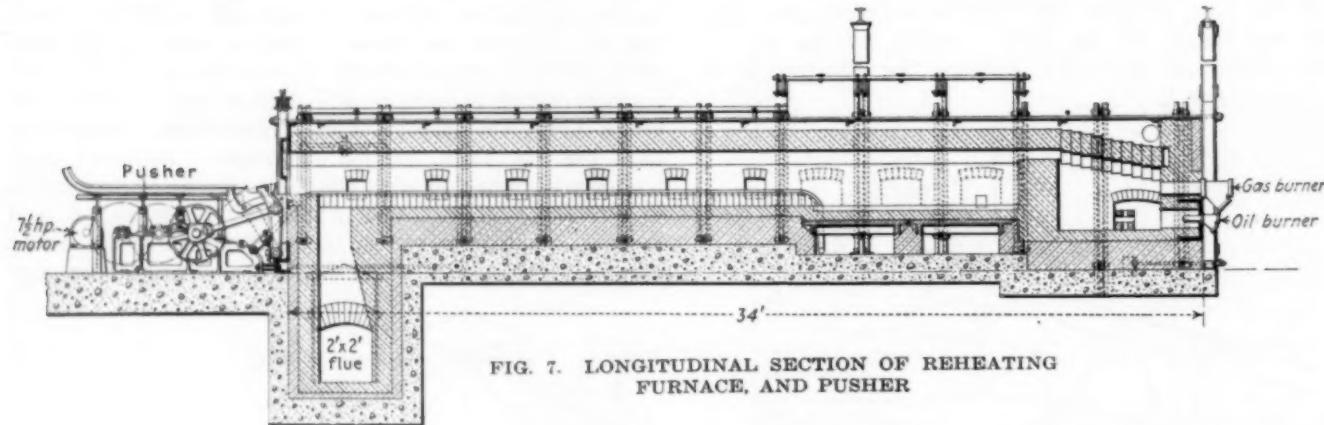


FIG. 7. LONGITUDINAL SECTION OF REHEATING FURNACE, AND PUSHER

under these guides at 3-ft. spacings are rollers which cradle the electrode; two pairs of side rollers also help maintain the alignment. Its up-and-down movement is effected by a pair of long screws threaded into the ring mentioned above, the screws being geared together by link chain at the top and hand-operated by ratchet. Fig. 4 shows a cross-section of this electrode cradle.

#### IRON SMELTING

Ore is brought in from the mine in 14-ton narrow-gage steel gondolas, with swinging side doors, very similar to the familiar ballast car. (These were favored over hopper-bottom cars, since they are a general-purpose car and can easily handle charcoal by merely adding to the height of the sides.) It is discharged from the stockpile into a jaw crusher, reduced to 2 in., and elevated by a counterweighted skip carrying 3,000 lb. to a hopper in the roof of the furnace building. Thence it is drawn into a car on an automatic railway, discharging 3,000 lb. each trip to a chosen storage bin. All these operations are remote controlled.

These ore and limestone bins above the charging floor have a combined capacity of 250 tons. From bin to charging bell, the ore and stone are carried by a jib crane, bearing suspension scales and a large scoop.

which will be kept in standby condition, ready to take metal when the sides of the other require relining or in case of accident. It will be noticed that the mouth is much smaller and somewhat hooded, as compared with

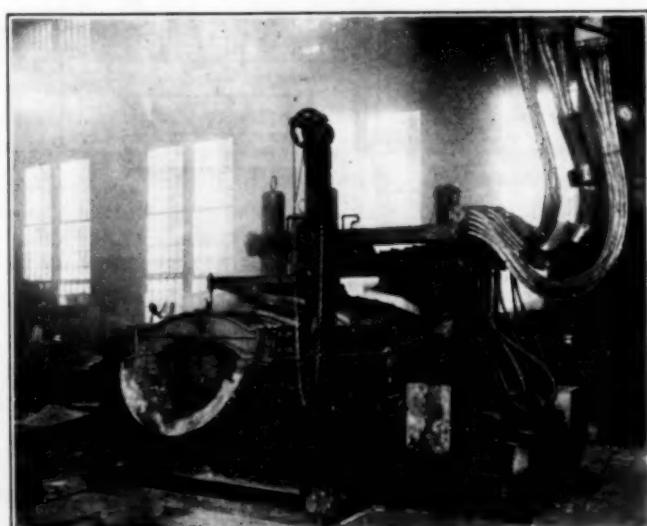


FIG. 6. LUDLUM FURNACE

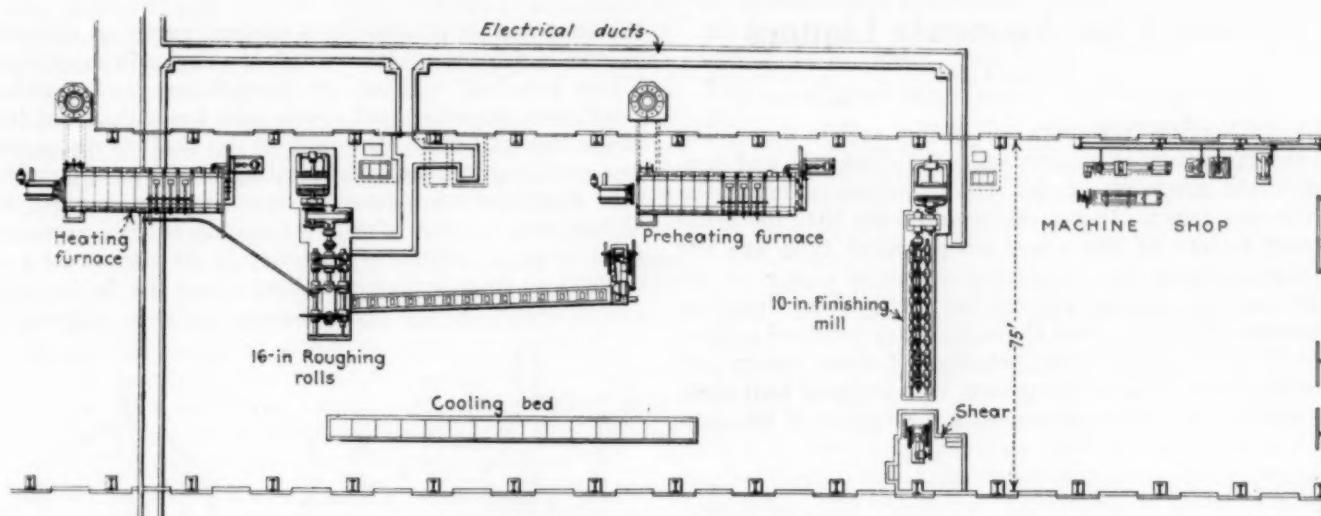


FIG. 8. PLAN OF ROLLING MILL

the vertical converter common to American plants, a feature necessary to conserve the heat during the long intervals between blows. Transfer of hot pig iron will be made by ladles and overhead cranes. One blowing engine only will be installed, and it will be in use not more than 2 hours out of the 24. It will be driven by a 6,000-volt, 700-kva. synchronous three-phase motor.

Blown steel will be rebarburized in the vessel—residual manganese is expected to cut down the needed deoxidizer to a minimum. It is then discharged into a 6-ton ladle, and teemed into solid or split ingot molds, 7 in. square by 4 ft. high, big end up. No stripper will be needed.

A 6-ton Ludlum electric steel furnace (Fig. 6) will be provided as an essential piece of emergency equipment. As noted, it will be in readiness to reheat cold pig, to quiet wild bessemer metal and, in addition, to reclaim mill scrap and on occasion make alloy steel or castings. This furnace, as is perhaps well known, is the original three-phase furnace having its three electrodes set in a row, an oval-shaped, accessible hearth, with doors at each end and a removable roof. The plan, Fig. 2, shows its location alongside the converters; it is commanded by a 6-ton crane. Its electrical equipment is located in the substation immediately adjacent and consists of one 1,500-kva. General Electric transformer, with all necessary instruments and automatic electrode control.

#### ROLLING MILLS

Ingots are reheated in a long furnace shown in Fig. 7, utilizing excess gas from the blast furnace in three burners, or oil, in case both furnaces are shut down. A rather unique feature is the fact that the roof is air cooled and the air is thus preheated for combustion. A simple pusher is installed to feed the furnace.

Two merchant mills of the conventional type are being installed; the plan is given in Fig. 8. They deserve no special description. The roughing stand is a three-high 16-in. mill, reducing the ingot to a 2-in. square. Finishing is done in a 10-in. mill, stands three-high, and the finishing stand two-high. Rolls for making rounds, flats, squares and various types of merchant bar and concrete reinforcement, as well as light angle iron, will be provided. Each mill will be driven by a 6,000-volt, 500-kva., three-phase induction motor.

The government is naturally interested in the beginnings of this industry, financed as it is exclusively by

Brazilian capital, and has permitted the entry of all the construction material duty free. All of the material has been shipped; construction of the plant is actively under way, and it is hoped that the furnaces may be blown in not later than March, 1922.

A technical staff and sufficient expert steel workers will be brought from Europe or America to act as executives and foremen, relying upon the country to supply unskilled labor. In course of time doubtless many of the more skilled posts will be filled by Brazilians.

Albany, N. Y.

#### Portland Cement Output Increases in October

There were appreciable increases in both production and shipments of portland cement in October, 1921, notwithstanding the seasonal trend. The production exceeded that of October, 1920, and according to available statistics was the largest ever recorded for a single month. The production for the first 10 months of 1921 was greater than the production during the corresponding period of 1920 and about 10.5 per cent in excess of the average for the same period during the 5 years 1917-1921.

The production of clinker, or unground cement, in October was approximately 9,891,000 bbl. Clinker production for the 10 months amounted to approximately 82,419,000 bbl.

The statistics shown in the following table, prepared under the direction of Ernest F. Burchard, of the United States Geological Survey, are based mainly on reports from producers of portland cement and in part on estimates.

#### PORLTAND CEMENT STATISTICS FOR FIRST 10 MONTHS, 1921

Month	Production, Bbl.	Shipments, Bbl.	Stocks at End of Month, Bbl.
January.....	4,098,000	2,539,000	10,300,000
February.....	4,379,000	3,331,000	11,400,000
March.....	6,763,000	6,221,000	12,000,000
First quarter.....	15,240,000	12,091,000	.....
April.....	8,651,000	7,919,000	12,600,000
May.....	9,281,000	9,488,000	12,450,000
June.....	9,296,000	10,577,000	11,150,000
Second quarter.....	27,228,000	27,984,000	.....
July.....	9,568,000	10,301,000	10,414,000
August.....	10,244,000	12,340,000	8,280,000
September.....	10,027,000	11,329,000	6,953,000
Third quarter.....	29,839,000	33,970,000	.....
October.....	72,307,000	74,045,000	.....
First 10 months.....	10,506,000	12,114,000	5,348,000
	82,813,000	86,159,000	.....

## Meters for Ammonia Liquors

BY A. THAU

Superintendent of the Oxelösund Coke Works, Sweden

**I**N CONNECTION with an earlier article describing the operation of column stills for ammonia and benzene,<sup>1</sup> the metering of the liquors before entering the stills was urged. It was also pointed out that the usual water meters of the wheel or propeller type are not always adapted for measuring ammonia liquor or oil. The positive acting piston-type meter was therefore recommended, and since the author has received a number of inquiries as to the principle of these meters and the details of their construction, it is believed that their description may be received with a measure of interest.

The metering of clean and neutral liquids to a high degree of accuracy does not present any difficulties, but when it comes to measuring liquids fed into stills, such as ammonia liquor or benzolized oil, special precautions must be taken to insure a continuous feed and at the same time an accurate record of the volumes which have passed through the meter and still. Both the ammonia liquor and benzolized oil react alkaline, and furthermore they are seldom free from solid substances. The alkaline reaction makes it impossible to use copper, brass, bronze, nickel or aluminum for the internal parts of the meters coming in contact with the liquid, and in the presence of benzene, vulcanite is also attacked and is therefore objectionable. For these reasons the usual water meters are impracticable for this purpose and they possess the additional disadvantage that they are easily obstructed by pieces of naphthalene or anthracene carried forward or held in suspension by the liquids. Filtering vessels to retain the solids before entering the meter soon become obstructed and check the flow.

Other means of measuring the liquids are resorted to in most cases. Weir meters which record the volume of the liquor or oil in accordance with the height of the

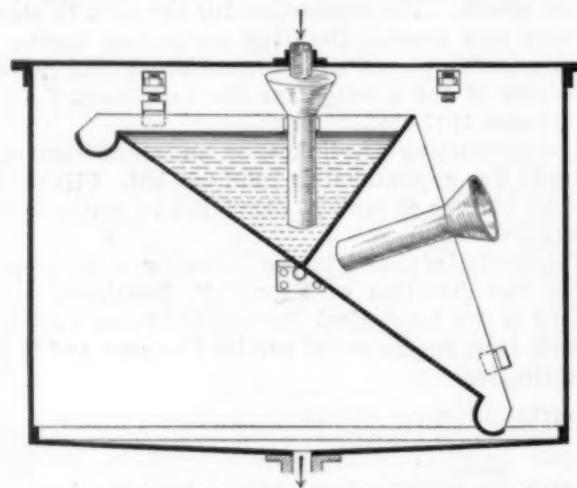


FIG. 1. A TILTING DEVICE FOR METERING LIQUIDS

liquid passing over the weir are often used. As reliable as they may be for clean water or oil, any solid substances obstructing even a small area of the weir temporarily affect the accuracy of the measurements.

Another type of flow meter consists of two vessels which are filled and emptied alternately and by recording the number of fillings give an indication of the volume passed. For example, tilting vessels, such as are shown in Fig. 1, are frequently applied. This

<sup>1</sup>Thau, A., "Ammonia and Benzene Column Stills," CHEM. & MET. ENG., vol. 23, No. 25, pp. 1203-7, Dec. 22, 1920.

tilting vessel is divided by a central partition directly above the pivoted shaft on which the device is supported. When one half is filled, it overbalances and empties itself, and the other half comes into the filling position under the feed pipe. One end of the shaft is connected to a counting mechanism indicating or, by a supplementary electrical arrangement, recording the number of fillings over a given time. As simple as this arrangement looks, its degree of accuracy is not very great and there is no immediate indication in case the device gets out of order. If the pivots become worn or unhooked,

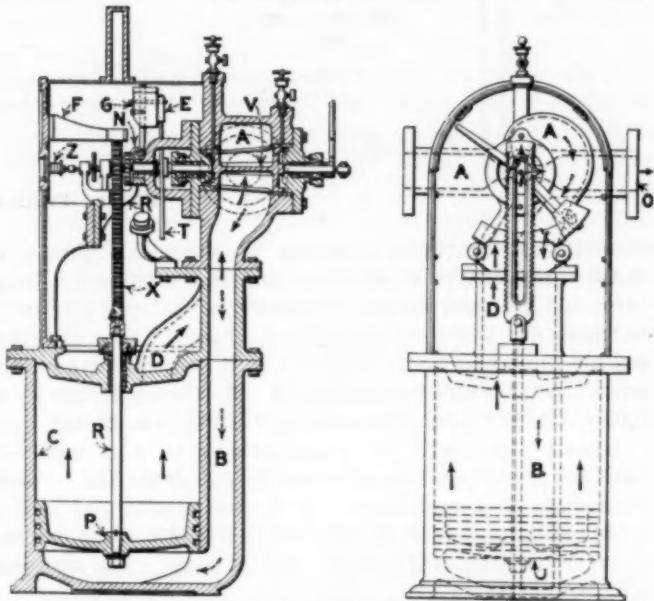


FIG. 2. VERTICAL SECTION AND ELEVATION OF PISTON-TYPE METER

the liquor will simply pass forward without the vessel tilting and the volume is then not indicated on the index. Even when the device is working properly a certain spill during tilting must be taken into consideration. This is naturally omitted on the records and is difficult to estimate, as its proportion varies with the amount of feed. All these measuring devices have also the great disadvantage that they must be placed at such a height that their outlet provides sufficient head for feeding the stills; consequently they are usually erected in the most inaccessible and unobservable places.

One type of meter which can be placed into the feed pipe of the still near the floor level is the flow meter previously described in these columns,<sup>1</sup> and while it is quite reliable, it only gives indications of the volume passing through the feed pipe at the time of observation. It does not add, as is expected of a meter from which a continuous record is obtained.

The disadvantages of these measuring devices are largely overcome by the use of the positive acting piston-type meter. This is a very reliable apparatus, of simple design, and its indications are very accurate. The meter is shown in vertical section and in elevation in Fig. 2. In its principle it resembles very much that of a steam engine, where the cylinder serves as a measure and the piston rod acts upon a valve causing the piston to reciprocate, at the same time acting upon the mechanism of a dial index to record the amount of liquid which has passed through the meter.

In Fig. 2 C represents a vertical cylinder which holds

<sup>1</sup>CHEM. & MET. ENG., vol. 23, No. 25, p. 1206, Dec. 22, 1920.

the piston *P* with rod *R*. The cylinder *C* is machined inside and the piston is provided with three cast-iron piston rings to give it an absolutely tight fit. The bottom and the top of the cylinder are each provided with port holes, the former being connected by the passage *B* and the latter by *D* to a common four-way valve *V* on top. This valve separates the inlet branch *A* and outlet branch *O*. The top of the piston rod *R* carries a double rack *X* which is slotted through in its center to enable the shaft of the valve *V* to pass through it without hindering the vertical movement of the rack. On its upper end the rack engages with gear wheels, by means of which it turns the toothed wheel *N*. In revolving, the wheel raises the balance weight *G* fixed to a lever and lifts it up so high that it overbalances and drops down to its opposite side, its fall being terminated by a soft buffer arranged on each side. A projecting edge *E* on the weight *G* comes in contact with lever *T*, which operates valve cone *V*.

The liquor enters at *A* and is conducted by the corresponding position of the valve *V* to the passage *B*, thus entering the cylinder *C* from the bottom and lifting the piston *P* to its highest position. At the same time the liquor filling the cylinder space above the piston is forced by the raising of the latter through the passage *D* and the corresponding ports of the valve *V* to the outlet branch *O*. When the piston has reached its highest position, the rod *R* and rack *X* cause the balance weight *G* to overturn, thereby giving the valve cone *V* half a turn, so that the flow of the liquid through the cylinder is reversed. The liquor enters now through the passage *D* and presses the piston downward, forcing the liquor underneath the piston to be expelled through the passage *B* and to be conducted through the valve *V* to the outlet *O*. The overturning of the weight *G* and the reversing of the valve, when the piston reaches its highest or lowest position respectively, is effected so rapidly that the continuous flow of the liquid is in no way interrupted. The strokes of the piston are transmitted to the meter index *Z* by means of gear wheels which are held by the bracket *R* indicated in liters or gallons. The meter is provided either with the ordinary gas meter index with five dials and pointers or with a row of jumping figures like those on meters for measuring electric current.

#### ADVANTAGES OF THIS METER

The indications of the meter are accurate to 1 per cent and are guaranteed not to vary more than  $1\frac{1}{2}$  per cent, a margin which must be considered very close for the purpose they serve. For use in connection with ammonia or benzene plants, the interior parts of these meters coming in contact with the liquids are made entirely of iron, while in the case of measuring fresh water some parts, such as the piston, piston rod, top gland and valve cone, can be made of brass or bronze.

A number of these meters are in use in England and on the European Continent for varying purposes, in the majority of cases as feed-water meters for boilers, and offer the advantage that they can be placed into the pressure feed pipe between feed pump and boiler. For this purpose the meters are tested to withstand a pressure of 300 to 375 lb. per sq.in.

The meters used in connection with boilers are connected into the feed pipe at a convenient place on the pressure side of the pump. In the case of ammonia or benzene stills, they are connected to the feed pipe between the high level tank and the still and are placed

at a convenient and easily accessible position on the ground floor. They require very little pressure for acting, 70-in. water gage being sufficient to use them. Much higher pressures are required for feeding the stills.

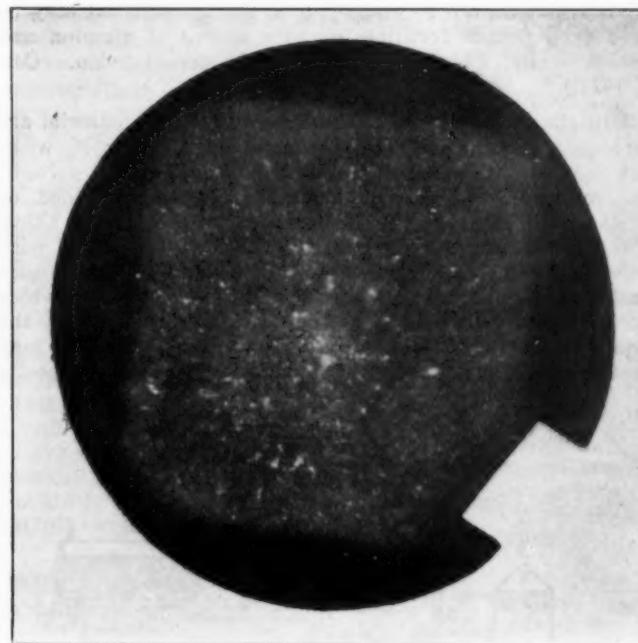
It may be further mentioned that with the exception of the piston all movable parts are open, can be observed during working and are readily accessible. No gears are exposed to the liquid to be metered and the pressure resistance of the meter is scarcely noticeable. The temperature of the liquid passing the meter does not affect its working and the four-way valve is so constructed that it can be tightened while the meter is in operation. The speed of the liquid passing through the meter is comparatively slow and the piston makes two to ten double strokes per minute. By these means the wear and tear of such meters is very small and their upkeep very slight. Obstructions do not generally interfere and therefore filtering arrangements are not required.

#### "Squaring a Circle"

BY C. T. PATTERSON

The accompanying photograph gives one way to solve the classical problem, "How to square a circle."

It is a sulphur print of a shaft which failed after a very short life. The section was polished and laid on a film saturated with 4 per cent H<sub>2</sub>SO<sub>4</sub>. The film was then fixed, washed and dried in the usual way, and it now



"A SQUARED CIRCLE"

serves to make any number of exact duplicates of a single sulphur print.

Sulphur contents of the center and outside are respectively 0.11 and 0.05 per cent.

The shape of the segregate may be explained by the idea that the steel, cast in a square mold, built up a segregate forming a roughly cylindrical or conical volume in the center. When the square ingot was rolled to a 3½-in. round bar, the circular segregate was squared. Part of the bar was then turned down to 2½-in. for a piece of shafting, and the result was as shown in the illustration.

Solvay, N. Y.

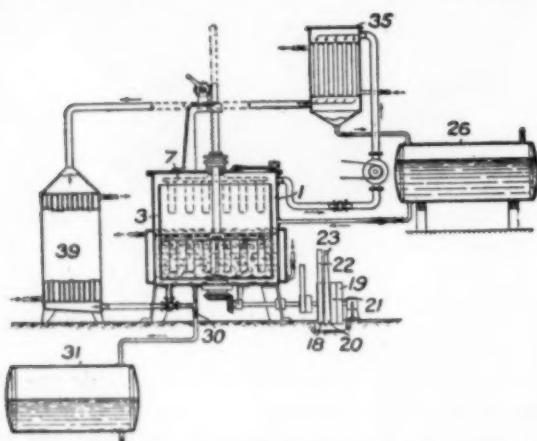
## Recent Chemical & Metallurgical Patents

### British Patents

For complete specifications of any British patent apply to the Superintendent, British Patent Office, Southampton Buildings, Chancery Lane, London, England.

**Alum and Aluminum Sulphate From Alunite.**—The invention consists in the preparation of alum and aluminum sulphate from alunite without the use of sulphuric acid. The coarsely crushed ore is roasted, preferably in the absence of material quantities of air and in a furnace in which the ore is passed down a series of hearths, the bottom one or more of which are heated to 700-900-deg. C. The sulphur dioxide, sulphur trioxide and oxygen which are evolved thus come in contact with the descending alunite and the iron oxide contained therein, acting as a catalyst, causes the sulphur dioxide and oxygen to recombine. The gaseous products from the furnace pass over some ground previously calcined alunite in a drum or chamber into which sufficient water is sprayed to convert the sulphur trioxide into sulphuric acid, whereupon a substance is produced from which alum and aluminum sulphate are obtained by lixiviation. The alum and aluminum sulphate may be separated by fractional crystallization or sufficient potassium sulphate, which may be obtained by extracting another portion of calcined ore with water, is added to combine with the free aluminum sulphate to form alum. The residue of calcined alunite that cannot be employed as above described may be used as a potash fertilizer or as a source of alumina and potash. (Br. Pat. 167,555. A. Matheson, London. Oct. 5, 1921.)

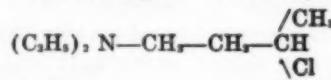
**Utilizing Waste Rubber.**—Rubber and textile material are recovered from waste rubber fabric by treating it, without reducing it to a state of fine division, with a solvent, the material and solvent being heated and kneaded or agitated under pressure, the temperature not rising above 130 deg. C. For this purpose the fabric is introduced with solvent into a rotary perforated cage 3 in an airtight steam-jacketed chamber 1. Stirring blades 7 are provided which do not rotate with the cage, but can be raised out of the liquid as shown. Ribs, etc., on the interior of the cage may assist in the agitation. The cage 3 is rotated in opposite



directions alternately by gearing comprising fast and loose pulleys 18, 19, 20, 21 and straight and crossed belts 22, 23. When the operation is completed, the solution is run off through a cock 30 into a vessel 31, and the cage rotated rapidly to expel the remainder of the solution. The fabric is then washed with a fresh charge of solvent which is similarly expelled. Air or an inert gas is then circulated through a heater 39, the chamber 1 and a condenser 35 to

remove the last traces of solvent, which are collected in a vessel 26. The solution and the solvent which has been used for washing may be collected separately. (Br. Pat. 167,667. F. Waitz, Bremen, Germany. Oct. 5, 1921.)

**Dialkylaminoalkyl Compounds.**—Dialkylaminoalkyl compounds are prepared by interaction of halogenalkyldialkylamines and the alkali salts of compounds of the type R.CO.CHR<sub>1</sub>.X, where R, R<sub>1</sub> are hydrogen or any radicals and X is an electro-negative group such as —COOC<sub>2</sub>H<sub>5</sub>, —CO.CH<sub>3</sub>, —CO.C<sub>2</sub>H<sub>5</sub>, —CN; for example acetoacetic ester, cyanacetic ester, malonic ester, acetonedicarboxylic acid ester, camphorcarboxylic acid ester, succinyl-succinic acid ester, acetylacetone; alternatively, the compounds may be prepared from halogenalkyl derivatives of bodies of the above type, such as bromethylacetate or bromethylacetoacetic ester and dialkylamines. According to examples the following compounds are prepared: α-diethylaminoethylacetocetate from sodioacetoacetic ester and chlor- or bromethylidethyldiamine, or from α-bromethyl-acetoacetic ester and diethylamine; α-diethylaminoethyl-acetoacetic methyl ester; α-dimethylaminoethyl-acetoacetic ethyl ester; diethylaminobutyl-acetoacetic ethyl ester; diethylaminoethyl-malonic diethyl ester; diethylaminoethyl-cyanacetic ester; bis-diethylaminoethyl-diketohexamethylene dicarboxylic acid diethyl ester from sodio-succinylsuccinic acid ethyl ester and chloorethyldiethylamine; diethylaminoethyl-acetonedicarboxylic acid diethyl ester; diethylaminoethyl-camphorcarboxylic acid methyl ester; diethylaminoethyl-acetylacetone. Chloorethyldiethylamine is made by adding diethylaminoethanol to thionyl chloride in chloroform solution and decomposing the hydrochloride with potassium carbonate. Bromethylidethyldiamine is made by boiling diethylaminoethanol hydrobromide with hydrobromic acid of 48 per cent strength. Chlorbutyldiethylamine

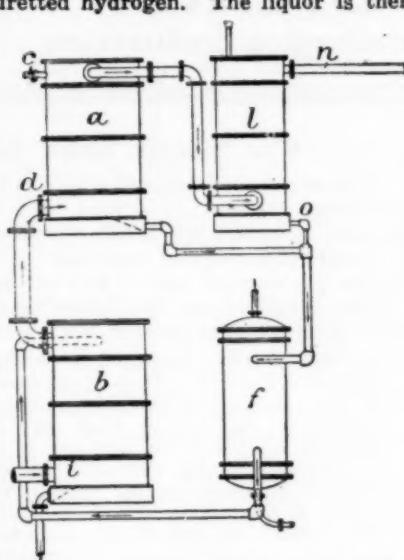


is made by reducing the corresponding diethylaminobutanone to the alcohol and treating the latter with thionyl chloride. The dichloorethylate of diethylpiperazine is obtained as a byproduct in the preparation of α-diethylaminoethyl-acetoacetic ester. (Br. Pat. 167,781; not yet accepted. Farbwerke vorm. Meister Lucius und Brüning Hoechst-on-Main, Germany. Oct. 5, 1921.)

**Tanning.**—Hides, preferably after being subjected to a high vacuum, are tanned under pressure by liquor from which all air has been removed. Treatment with thin glue or gelatine may follow. The depilated and preferably dried hides are suspended in an autoclave and subjected for 30 to 60 minutes to a high vacuum, a strong tanning liquor from which all air has been removed by passage through a vacuum machine, etc., being then pumped in, preferably under a pressure of from 20 to 40 lb. per sq.in. After the tanning liquor has been run off, the hides are washed, and a solution of thin glue or gelatine is forced into the pores by alternate high vacuum and high pressure. The hides may be again washed and are dried in vacuo, small quantities of hot air being admitted, preferably through a red-hot-pipe. (Br. Pat. 167,785. A Mauvers, London. Oct. 5, 1921.)

**Separating Organic Substances by Distillation.**—The separation of the constituents of mixtures such as crude resorcinol, crude anthracene cake, crude anthraquinone, etc., is effected by distilling the substance with a mineral oil, such as kerosene, fuel oil, etc., containing fractions which boil within wide limits. The constituents of the mixture distill over with the oil at different stages and are collected separately. Alternatively, a mineral oil fraction having a boiling point above that of any of the constituents of the mixture to be separated is used. The mixture is heated and at various stages in the rise of temperature steam is passed through the mixture to carry off the constituents separately in the order of their volatility. In treating crude anthracene cake carbazol passes over first, then anthracene, and finally phenanthrene. (Br. Pat. 168,108. Berk & Co., Ltd., and J. J. Hood, London. Oct. 12, 1921.)

**Ammonium Sulphides.**—In preparing ammonium sulphide or polysulphide, ammoniacal liquor is heated under such conditions of temperature and pressure as to expel carbon dioxide but not sulphuretted hydrogen. The liquor is then distilled to obtain ammonia solution containing ammonium sulphide, which is treated with sulphuretted hydrogen prepared, for example, from iron sulphide and sulphuric acid, to yield ammonium sulphide or, if sulphur be added, ammonium polysulphide. The ammonium liquor is treated in an apparatus comprising two columns *a*, *b*. The liquor enters the column *a* by inlet *c* and is treated by the vapors from the column *b* entering by pipe *d*. The liquor passes from column *a* through a cooler *f* and then to the top of the column *b*, in which it is treated with steam from a pipe *i*. The liquor passes from the base of the column to an ammonia still. The vapors from the column *a* pass to a column *l*, in which they are washed with water. The unabsorbed gases escape by a pipe *n* and the wash water passes by a pipe *o* into the liquor leaving the column *a*. The temperature at the steam inlet *i* may be kept at 98 deg. C., and the pressure at 16 lb. per sq.in. absolute. Higher temperatures and higher pressures or lower temperatures and lower pressures may be used. (Br. Pat. 167,540. South Metropolitan Gas Co. and P. Parish, London. Oct. 5, 1921.)



## Book Reviews

**AMERICAN SULPHURIC ACID PRACTICE.** By Philip De Wolf and E. L. Larison. Pp. 270; 85 illustrations, New York: McGraw-Hill Book Co., Inc., 1921. Price, \$3.50.

One feels that the authors of this little book have perhaps attempted too much in an effort to cover so general a subject as "American Sulphuric Acid Practice" in such limited space, and this is, perhaps, the cause of the somewhat disconnected and more or less unrelated style employed. To lack of space may be due also the authors' failure to give supporting evidence for statements which are sometimes at variance with opinions generally held among acid men.

Most noticeable of these unsupported statements is the remark on page 6, where, in a discussion of the relative merits of "contact" and "chamber" processes, the authors state: "Supervision, regulation and yield are all better on a contact plant, while depreciation and maintenance are less." This is so entirely contrary to the reviewer's experience that he feels that perhaps an error has been made in printing and that for "contact" one should read "chamber."

The part of the book devoted to the chamber process is, on the whole, more complete and better written than that devoted to the contact method. It is somewhat surprising, however, to find that in a book on American sulphuric acid practice no mention is made of Pratt chambers, as it is probable that more chamber acid is made in the United States in Pratt sets than in any other special type of chamber.

While the descriptions of various apparatus and methods for the production of SO<sub>2</sub> are interesting, it would seem that a little more detailed information on actual acid manufacture might well have been incorporated at the expense

of descriptions of sintering machines and the production of liquid SO<sub>2</sub>.

The latter criticism—that is, space used on unimportant points—might also be applied to the description of the supplying of niter to chambers by the oxidation of ammonia, especially since, by the authors' own statement, only one such installation exists in this country.

In the description of the contact method, the effort to cover the whole subject in a very limited space is particularly noticeable and has resulted in a series of more or less unrelated statements rather than a connected discussion. Some of these statements are very good; others are of little importance.

It is assumed by the reviewer that a misprint is responsible in Fig. 80, page 241, for the word "converters" under a picture showing coke boxes and mineral wool filters.

The tables in the back of the book are good.

While this book has an undoubted value in the literature of acid making in that it is the first effort of independent authors to cover the American field, one finishes reading it with a feeling that the subject might have been better handled by the expenditure of a little more effort and by more attention to literary style.

THOMAS R. HARNEY.

### CHEMICAL REACTIONS AND THEIR EQUATIONS.

A Guide and Reference Book for Students of Chemistry. By I. W. D. Hackh, professor of biochemistry, College of Physicians and Surgeons of San Francisco. Philadelphia: P. Blakiston, Son & Co. Price, \$1.25.

This is one of the most convenient and helpful little books we have come across in a long time. It is small enough to carry in a side pocket, contains only 138 pages, and does not profess to cover any more ground than its title indicates. The author found so many graduate students who were unable to balance an incomplete ionic equation that he wrote the book for them. It confines itself merely to a consideration of purely chemical equations from a technical and arithmetical standpoint. There are six chapters, treating respectively of: Symbols, Formulas, Equations Involving No Oxidation or Reduction, Equations Involving Oxidation and Reduction, Reactions and Their Control, and Types of Chemical Reactions and Equations. After each chapter a group of carefully chosen questions reviews the subject comprehensively. It concludes with an appendix which adds a Key to Nomenclature, With a List of Radicals, Ions and Valence Numbers, Displacement Series of the Elements, Periodic System and Classification of Elements, Solubility Table of Compounds, Preparation of Salts, Key to Equations, and an Index and Glossary of Chemical Terms.

A vast amount of useful information is condensed into a small space, and a large number of facts are conveniently arranged. It is bound to be not only a very present help in the study of chemistry, but also a handy book for the forgetful chemist.

ELLWOOD HENDRICK.

**TECHNICAL METHODS OF ANALYSIS**, as employed in the Laboratories of Arthur D. Little, Inc. Edited by Roger Castle Griffin, Director of Analytical Department, Arthur D. Little, Inc. International Chemical Series. 666 pp., 5½ x 8, 29 illustrations. Price, \$6.

The author is to be commended for the comprehensive and concise manner in which he has covered a very wide range of quantitative analytical methods. This book should be very helpful to those interested in general analytical work. The main body of the text is supplemented by a bibliography which refers to many standard treatises on special subjects. A chapter on "The Analysis of Textile Fibers" contains much valuable information not commonly found in other standard works on quantitative analysis. There are few noticeable omissions to be pointed out, except possibly the failure to mention an additional method for the determination of cotton in asbestos-cotton twine. Cotton is readily and fairly accurately determined by combustion in a stream of oxygen, weighing the resultant carbon dioxide and calculating to cellulose. On the whole the book possesses great utilitarian value in the hands of the analytical chemist.

A. F. SHUPP.

## Current Events

### in the Chemical and Metallurgical Industries

#### More Plants Increasing Operations

**Glass.** The Thatcher Glass Co., Dunkirk, N. Y., has resumed operations at its local bottle-manufacturing plant under a 24-hour working schedule, following a two months' shut down. About 150 men will be employed. The company has made improvements at the works to an amount of about \$100,000.

The Lippincott Glass Co. will soon place a 10-pot furnace in operation at its Alexandria, Ind., works, giving employment to about 200 men. Repairs and improvements preparatory to resumption are now being made. The local plant will commence the manufacture of glass tumblers in the near future.

**Ceramic.** The Hall China Co., East Liverpool, Ohio, has resumed operations at its No. 2 plant, following a period of curtailment. There is now only one semi-porcelain manufacturing plant idle in this district.

The Crouse Clay Products Co., Akron, Ohio, manufacturer of brick, has increased operations to normal at its plant.

The Cincinnati Clay Products Co., Cincinnati, Ohio, manufacturer of brick, has increased production at its plant, giving employment to a considerably increased working force as compared with this time last year.

The Atlantic Terra Cotta Co. and the Federal Terra Cotta Co., with plants at Perth Amboy, N. J., are increasing the working forces in the different departments of their factories.

**Paper.** The Universal Paper Bag Mill and the Union Paper Mills, both of New Hope, Pa., have adopted a full-time operating schedule at their plants.

**Chemical.** The du Pont Chemical Co., Pennsgrove, N. J., has added about 1,000 employees at its Deepwater Point plant, bringing the working force up to a total of 2,500 operatives. Further increase in the number employed is expected at an early date.

**Rubber.** The Rubber Products Co., Barberton, Ohio, has adopted a night working schedule at its plant.

**Oil.** The Tidewater Oil Co., Bayonne, N. J., has resumed operations at its refineries, following a strike of operatives. A settlement with the men was arranged on a basis of 12 per cent wage reduction.

The New York Petroleum Corporation, El Dorado, Ark., has commenced production at its new local refinery under full capacity, totaling about 2,000 bbl. of oil per day.

**Glue.** The Perkins Glue Co., Lansdale, Pa., has placed an overtime working schedule in force, including night and Sunday operations.

**Soap.** The Procter & Gamble Co., Cincinnati, Ohio, is maintaining capacity production at its local plant.

**Leather.** The American Hide & Leather Co., Sheboygan, Wis., has increased operations at its local tannery to close to normal production.

The Badger State Tannery, Sheboygan, Wis., is giving employment to about 225 operatives, who are turning out the same ratio of leather as did 400 employees prior to the fire at this tannery in January, 1920, due to improved machinery and better working conditions, with modern buildings. Production is near to normal.

**Iron and Steel.** The Carnegie Steel Co., Youngstown, Ohio, has blown in its fifth blast furnace at its Ohio works, bringing production up to over one-third of normal.

The Trumbull Steel Co., Youngstown, Ohio, has placed eight of twelve mills in operation at its Liberty plant, which has been idle for eight months past.

The Portage Foundry Co., Barberton, Ohio, has increased production to more than 60 per cent of normal.

The Berks Foundry & Manufacturing Co., Hamburg, Pa., has adopted a full-time operating schedule at its plant, with increased force of molders.

#### War Minerals Relief Act Modified

Without the necessity of a roll call, the House of Representatives on Nov. 22 agreed to a Senate amendment to the war minerals relief bill which removed the necessity of re-appropriating the remainder of the war minerals fund for the payment of additional awards. The bill was signed by the President on the following day, thus becoming a law. This measure amends the original act as follows:

Add to the first paragraph of Section 5 the following proviso: "Provided, That all claimants who in response to any personal, written or published request, demand, solicitation or appeal from any of the government agencies mentioned in said act, in good faith expended money in producing or preparing to produce any of the ores or minerals named therein and have heretofore mailed or filed their claims or notice in writing thereof within the time and in the manner prescribed by said act, if the proof in support of said claim clearly shows them to be based upon action taken in response to such request, demand, solicitation or appeal, shall be reimbursed such net losses as they may have incurred and are in justice and equity entitled to from the appropriation in said act."

"If, in claims passed upon under said act, awards have been denied or made on rulings contrary to the provision of this amendment, or through miscalculation, the Secretary of the Interior may award proper amounts or additional amounts."

The measure includes an amendment proposed by Representative Anderson, of Minnesota, which broadens the language so as to allow claims when a written notice of their existence was filed prior to the expiration of the time limit. This amendment is understood to have been intended to admit two Minnesota claims totaling about \$750,000.

#### Asbestos Industry Shows Marked Improvement

Reports from leading companies in the asbestos products industry show a marked improvement in the business in this line, and increasing volume of orders. The Johns-Manville Co. reports record sales in October as compared with other months of this year, and more asbestos shingles were sold during that month than at any other time in 1921. The Keasbey & Mattison Co. reports a 100 per cent increase in business during this same month, with marked prospect for further advancement. The Keystone Asbestos Co. states that there has been considerable improvement in the orders placed for building and insulation asbestos, while the Ehret Magnesia Mfg. Co. reports 35 per cent increase in October sales as compared with the preceding month.

#### Increased Appropriation for C.W.S. Approved

The President and the director of the budget have approved a request for an appropriation of \$1,500,000 for the Chemical Warfare Service during the next fiscal year. This is an increase of \$150,000 over the amount appropriated for the current fiscal year. Among the items making up the total asked for next year's work are: Salaries and wages, \$1,007,444; materials and equipment for research and experimentation, \$143,023; chemical supplies, \$65,000; offense appliances and supplies, \$40,000; gas mask materials, \$21,000. These estimates of expenditure were submitted to Congress by the President on Dec. 5.

#### Employment Increases in Chemical Industry

There was an increase of 1.3 per cent in employment in chemical industries during November, according to a report issued Dec. 5 by the United States Employment Service. There was an increase of 0.46 per cent in employment throughout the country during November.

### A Tribute to Canadian Business Papers

Ontario's Lieutenant-Governor, Colonel Henry Cockshutt, president of the Cockshutt Plough Co., Director of the Bank of Montreal, etc., himself an outstanding success as a business man and financier, paid an understanding tribute to the business papers of Canada when, speaking at a luncheon in connection with the annual meeting of the Canadian National Newspapers and Periodicals Association at the King Edward Hotel, Toronto, on Thursday, Nov. 10, he said:

"I am especially glad to be with you today because I believe that the influence of the business press will be one of the most important factors in re-establishing business conditions in Canada on a safe and sane basis. I make a distinction between the business newspapers and the daily press, because I believe that your papers—the business newspapers of Canada—exert a greater influence than the daily press because of the greater confidence your readers have in them. People read the daily newspapers to satisfy their desire for excitement or interest or entertainment. But this is not the case with the business newspaper. Business men need the service of these papers in the conduct of their everyday business life.

"You should be very careful that everything that appears in your columns bears the imprint of the truth. You must be sure that the news you give is correct beyond question, because there are thousands of your readers ready to set their business course by the news and advice you give them.

"In these days when there is disorganization, dissension, disruption in all walks—business, politics and religion, there is a great place for the business paper to bring out more complete information, to assist in making us all realize we must work for a common cause—the upbuilding of our country. The business men of this country need your assistance. They are looking to you for information and advice, and are expecting it. On your shoulders therefore, perhaps more than on the shoulders of any other single agency, rests the obligation to meet the needs of these trying days, with a sane and sound presentation of the case as it exists at the present time, a presentation free from private bias or the desire to serve a popular demand."

### Fundamental Research Program for Cotton Seed and Cottonseed Products

Pursuant to the memorials adopted at the last meeting of the American Oil Chemists' Society and the Interstate Cottonseed Crushers' Association in Chicago in May of this year, a joint committee of the two organizations met with the officials of the U.S. Department of Agriculture of Washington for the purpose of acquainting them with the needs of the industry in certain lines of research, endeavoring to obtain their aid in having studies along these lines actively prosecuted and establish more intimate relations between the Agricultural Department and the cottonseed oil industry. To this end the committee recommended research along well defined lines incorporated in the following brief:

In the interest of the farmer producer, the converter of cotton seed into marketable food and the consumer of those products, we the basic research committee of the Interstate Cottonseed Crushers' Association and of the American Oil Chemists' Society, appointed at the suggestion of Secretary Wallace to advise and co-operate with the interbureau committee on oils and fats in the Department of Agriculture, respectfully submit to the department the following tentative program of research to be conducted in co-ordination by the various bureaus of the department having facilities and authority for such work.

(1) To develop varieties of cotton seed that will yield fiber of the maximum value and seed containing the maximum percentage of oil and also to determine the effects of cultural conditions.

(2) Isolation and identification of all constituents of crude cottonseed oil with special reference to effect on refining loss and quality. This would serve as a foundation for improvement in refining methods which will result in a larger yield of refined oil from the raw material and will also serve as the basis for a correct valuation of the crude oil.

(3) Continuance of work on rancidity with special reference to the nature and constitution of the products formed and their physiological effects. This will serve as the basis for determining why rancid fats are objectionable or harmful. It will also lead to a knowledge of methods for the prevention and removal of rancidity from oils and fats.

(4) Isolation and identification of constituents of cottonseed meal with special reference to feeding values. This will lead to the investigation of the so-called toxicity of cottonseed meal and establish definite information which will clear up any existing uncertainty regarding its use as feedstuff for all classes of farm animals. It will also furnish facts bearing upon the use of cottonseed meal for human use.

(5) The prompt publication from time to time by the department of results of its research in oils, fats and other products of the oil milling industry, and the revision or re-editing of all present bulletins, in cases of re-publication, with a view to correcting inaccurate data and conclusions based thereon. (Note. Reference is made here to Farmers Bulletin 36 and to Farmers Bulletin 1,179 and all other literature issued by the department in which the conclusions have been reached and data published that are not justified by present day information.)

(6) We ask that data of researches regardless of conclusions be made freely accessible to interested parties upon request.

This committee tendered its services in carrying out the above program and asks an opportunity to discuss with the department, from time to time, these research problems, their progress and contemplated publication. The committee offers to obtain and place at the disposal of the Agricultural Department all possible available data from the industry pertaining to its work.

On Oct. 4 the committee met with the officials in Washington and considered the matter from the standpoints of the various bureaus affected, with the result that plans are now under way for actively prosecuting these studies. In conjunction with this governmental research the committee on co-operation in research of the American Oil Chemists' Society has obtained from representatives of the industry, comprising chemists, technologists, engineers and producers, a list of problems which it is transmitting to the universities and experiment stations as a guide to them in planning such research along these lines as they may be in a position to prosecute.

### A.A.A.S. to Meet in Toronto

The seventy-fourth meeting of the American Association for the Advancement of Science will be held at Toronto, Canada, Dec. 26 to 31, by invitation of the University of Toronto and of the Royal Canadian Institute. Meetings of interest to chemists are, besides the meetings of Section C (Chemistry) itself, a joint meeting with the Canadian Institute of Chemistry and the Toronto Section of the Society of Chemical Industry, at which Prof. S. W. Parr, retiring vice-president for Section C, will give his address on "The Carbonization of Coal"; a joint meeting with the Plant Physiology Section of the Botanical Society of America, devoted to biochemistry and chemical aspects of plant and animal physiology; and a symposium on the quantum theory, jointly with the American Mathematical Society and the American Physical Society.

### Two Pottery Expositions Being Arranged

East Liverpool, Ohio, pottery manufacturers are arranging plans for two expositions early in 1922. The first will be held at Pittsburgh, Pa., in January, and upon the closing of the display it will be removed to Chicago, to be on exhibition there in February.

### Brunner Mond Dividend

The directors of Brunner Mond & Co., Ltd., chemical manufacturers, announce an interim dividend of 2½ per cent, less tax. For the corresponding period of the previous year the distribution was at the rate of 10 per cent, less tax.

### Successful Flight With Helium

The first practical demonstration of the use of helium for aircraft was made at Hampton Roads, Va., on Dec. 1, when the navy non-rigid airship C-7, filled with the gas, made two successful flights.

### Philadelphia Chemical Club Celebrates Anniversary

The Philadelphia (Pa.) Chemical Club, composed of chemical manufacturers and others in the local trade, celebrated the first anniversary of its organization with a dinner at the City Club on Nov. 19. Reports made at the meeting showed a large and growing increase in the membership. Major Maurice Mercadier, of France, gave an interesting talk on the subject of "Exchange," and A. J. Morse spoke on the topic of the "American Melting Pot."

### Merger Proposed to Establish Steel Industry in West

A plan has been proposed for the utilization of the enormous deposits of coking-coal and iron ore in Utah in establishing a steel industry to supply the Pacific Coast trade which now has to depend upon the Eastern manufacturers for finished products. The plan takes the form of a \$20,000,000 merger comprising a number of companies that control coal mines and iron ore deposits in Utah and two others that own and operate steel plants in California. Under the combination, iron ore from the deposits in the Iron Springs district of Iron County, Utah, limestone from the extensive quarries near Salt Lake City, and coke from a proposed byproduct coke plant would be smelted in a 500-ton blast furnace to be located near Utah Lake, 25 miles south of Salt Lake City. The pig iron would be shipped to the plants of the Columbia Iron & Steel Co., at Pittsburg, Cal., and at Portland, Ore., and the Southern California Steel Co.'s plant near Los Angeles. These plants would be expanded.

### Patent Office Continues to Degenerate

When Commissioner Newton was in charge of the Patent Office, in July, 1919, he testified before a committee of Congress to the effect that the situation in his bureau was deplorable and that it was in a worse condition at that time than at any other time since he had been in the service. His service began in 1891. The present Commissioner of Patents, in his report to Congress, points out that the degeneration has continued steadily since the testimony of Commissioner Newton. Between July, 1919, and June 30, 1921, the Patent Office lost 163 of its examiners. "These men," says the Commissioner in his report, "were scientifically trained and also members of the bar. They have been replaced by inexperienced men, fresh from college, without any knowledge of patent law and without legal training." Continuing, the report says:

"During the time the Patent Office has been losing the 163 men aforesaid, the number of applications received in this office has increased by leaps and bounds. The number of applications for patents has increased 34 per cent during the period under discussion, while the trade-mark applications increased 85½ per cent. In July, 1919, when Commissioner Newton testified, there were 18,000 patent applications awaiting action. There are now about 50,000 applications awaiting examination. It is further shown that a number of divisions are over 11 months behind in their work, and to illustrate the large turnover in the personnel, there is cited one of the chemical divisions where five out of the nine examiners have been appointed in the last few months. At the close of the fiscal year, one of these had been in the office only 1 week, another 3 weeks, another 7 weeks and another 2 months. One out of every four examiners has resigned in 16 months and more than one-half have resigned in 32 months. Relief is, therefore, imperative.

"It is shown that there are many industries which can not enter into development work on account of the doubtful status of their applications for patents. A bill is now pending in the House, H.R. 7077, which is designed as an emergency measure to help relieve the situation.

"Reference is made to the entrance salaries of the assistant examiners, who are a highly educated and picked corps of scientific men, who receive the same initial salary as clerks who perform routine duties in other branches of the government service. Note is made of the inadequacy of the salaries paid to these technical men as compared to their qualifications and the requirements of their position, showing the necessity of correcting the disparity of conditions.

"The receipts of money for the fiscal year just closed increased from \$2,615,697.33 of the previous fiscal year to \$2,712,119.69, or almost \$100,000. A net surplus of \$284,342.93 was earned, and if the bonus be subtracted therefrom, the surplus amounted to \$71,745.73, making the total net surplus to date—that is, the excess of receipts over expenditures during the history of the Patent Office—\$8,376,769.29.

"Emphasis is laid upon the figures given and the conditions cited to show that the volume of business presented to the Patent Office is altogether too large for the present personnel to perform properly."

### Alcohol Export Situation

So as to be able to take advantage of a demand for American alcohol in Europe, the producers of industrial alcohol in the United States are urging that this traffic be permitted to move without undue interference from the Bureau of Internal Revenue. Captain James P. McGovern, representing all the alcohol producers in the United States, has submitted the following statement to the Commissioner of Internal Revenue and to the Federal Prohibition Commissioner:

"A condition has arisen in Europe whereby, because of lack of raw material necessary for the manufacture of alcohol, there is a demand for the purchase of alcohol manufactured in this country to be exported to sundry European countries for legitimate industrial uses there."

"The disturbed conditions in Europe have curtailed the raw material, such as molasses, the result of the beet sugar crops in various European countries, and of grains and potatoes, which are used in other countries as raw material for alcohol. The great and almost universal drought in Europe during the last summer will further tend to a restriction of raw material for the manufacture of alcohol in those countries. The result is that there is and will be a real necessity for alcohol in Europe for the arts and industries and a demand for the exportation of alcohol produced in the United States. This foreign trade, which is legitimate, should not have an embargo placed thereon simply because there have been isolated cases of attempts by bootleggers and irresponsible parties to feign the exportation for the purpose of surreptitiously bringing it back into illegal consumption in the United States. The mere fact that our governmental authorities are aware of this and have been able in some cases to prevent it shows that under proper regulation and vigilance and honest administration of existing laws such shipments can easily be controlled. Under no circumstances should the producers of alcohol in this country be deprived of their legitimate and lawful right of exporting their commodity to foreign countries, particularly in the case of alcohol, where the foreign market for American alcohol will cease to exist just as soon as European raw material is available for the production of alcohol there. This is an opportunity for American producers to sell in the foreign market and they should not be deprived thereof, particularly as this is an opportunity which will only come once in a lifetime."

"A proper co-operation of the various departments of the Treasury—namely, the Internal Revenue and Customs Service—even under present existing laws and regulations, will certainly safeguard the enforcement of the prohibition laws in this country. The producers of alcohol in the United States are desirous of co-operating with the government along these lines and under any reasonable and practical regulations, but the attempt to establish regulations which are now unreasonable and unnecessary will prevent the foreign trade now with these producers and any such action would not only be unwarranted and unreasonable but actually in violation of the constitutional rights of American producers."

### Tax Bill Finally Approved

While the tax bill is admitted by its authors to be an imperfect measure, it does provide for a substantial reduction in the tax burden and greatly simplifies the administration of the law. The bill in its final form will require during the first fiscal year that it is in full operation the payment of about \$725,000,000 less than would have been raised had the law it supersedes remained in effect. The reduction will be greater when collections from the excess profits tax cease altogether.

The repeal of the transportation and so-called nuisance taxes means a reduction of \$326,630,266 during the fiscal year being July 1, 1921. That feature of the bill alone is held by many to justify its enactment. It was stated officially at the White House and by the chairman of the Finance Committee that the bill is intended as a temporary measure only. The great disappointment to business is that the recommendations of the Secretary of the Treasury were not carried into effect in the matter of transferring some of the higher brackets of the income tax to the estate tax title.

In its final form the bill is expected to yield \$3,216,100,000 in the fiscal year beginning July 1, 1922, and \$2,611,100,000 in the fiscal year beginning July 1, 1923. For the fiscal year of 1922 the bill is expected to raise about \$16,000,000 in excess of the government's requirements.

The Senate accepted the House rate of 12½ per cent applicable to the corporation income tax. This reduction of 2½ per cent from the rate proposed by the Senate will reduce by \$110,000,000 the annual tax burden on business. The lower rate is particularly advantageous to public utility companies and other corporations now earning small returns on their invested capital.

### Exports and Imports of Chemicals in October

There was a slight upturn in chemical exports in October. Chemicals sent abroad in October were valued at \$262,214 more than the exports of September. The October exports, however, were scarcely more than one-third the value of those in October of 1920. The slump was heaviest in dyes and dyestuffs. In October, 1921, the value of all American dyes and dyestuffs shipped out of the country was \$481,927. In October of 1920 the value of these exports was \$2,251,659. The comparative figures covering the principal groups are as follows:

	1920	1921
Acids	\$479,060	\$144,860
Dyes and dyestuffs	2,251,659	481,927
Extracts for tanning	201,358	136,295
Total soda	2,430,497	514,176

The value of all chemicals exported in October was \$4,671,310. This compares with \$13,701,882 in October of 1920.

While there was a decrease in imports of chemicals on the free list, there was a decided upturn in the imports of those on the dutiable list. In the latter class the value of the exports was nearly \$700,000 greater than in September. The total imports for October, 1921, were valued at \$7,127,853, of which \$4,342,505 represent chemicals on the free list and \$2,785,348 represent those on the dutiable list. In October of 1920 the value of free-list chemicals was \$13,393,424 and dutiable-list chemicals \$5,798,615. Imports of coal-tar products during October, 1921, were valued at \$992,014. This compares with \$2,492,174 in October of 1920. The imports of gums in October of 1921 were valued at \$1,455,915. In October, 1920, the imports of gums were valued at \$4,460,316.

### Independent Steel Merger Contemplated

Several independent steel companies have been considering a plan for arriving at a possible basis for consolidation. While the matter is still in a formative stage and very little definite information is obtainable, the following companies have been referred to in connection with the proposed merger: Republic Iron & Steel Co., Midvale Steel & Ordnance Co., Lackawanna Steel Co., Youngstown Sheet & Tube Co., Steel & Tube Company of America, Inland Steel Co., Brier Hill Steel Co.

### Chicago Ceramists Hold Meeting

The Chicago Section of the American Ceramic Society met at the Morrison Hotel on Nov. 26 for the election of officers and semi-annual program. E. M. Bunting, of the School of Ceramics, Illinois University, presented papers prepared by himself and Dr. Washburn, on a new method of porosity measurements.

The porosity of clay specimens has previously been measured by immersion in water; the new method involves the placing of a test specimen about 1 x 1 x 4 in. in a small special glassware container, filling the complete apparatus with mercury, and permitting the mercury to run out of the bottom of the chamber into a barometer tube graduated in millimeters. Measurements of the two quantities of pressure and volumes thus procured give a measurement of porosity which is 5 to 20 per cent higher than measurement obtained by the water vacuum method. This is easily accounted for in the fact that air is more fluid than water. Accuracy of reading is greater than 0.1 per cent. The apparatus will be described in full in the November issue of the *Journal of American Ceramic Society*.

J. A. Dedouch, of the Imperishable Minature Co., gave an impromptu talk on photographic colors worked into enamels. Every whiteware plant may make a ceramic photograph as easily as the ordinary method of decorating white ware.

R. M. Onan, of the Carborundum Co., spoke on refractories as used in enameling furnaces, describing the production of a new non-oxidizable carborundum refractory, and the making of large shapes up to 12 ft. in diameter and 6 ft. high for use in a Chicago water gas plant.

The following officers were elected for the coming year: F. L. Steinhoff, of the *Brick and Clay Record*, chairman; B. T. Sweeley, of the Coomley Manufacturing Co., vice-chairman; W. Wilkinson, of the Lewis Institute, secretary-treasurer. H. E. Davis will serve as chairman of the program committee, and E. A. Brockman as chairman of the membership committee.

### Drive on War Gases Expected

While the general subject of the use of gas in warfare has been taken up only in a preliminary way in the connection with the Conference on Limitation of Armament, there is reason to believe that formidable opposition to the use of gas in warfare will develop. No one has shown his hand in the open as yet, but the opponents of chemical warfare, both at home and abroad, very evidently will make a desperate effort to unseat chemical warfare from what they declare to be an undeserved position of respectability, made so by the official recognition it has received by the governments of the principal countries.

The committee which will consider chemical warfare in connection with the studies being made for the delegates to the conference is as follows: Dr. Edgar F. Smith, chairman; General Amos A. Fries, U. S. A.; Colonel W. H. Bartholomew, Great Britain; Charles Moureu and Prof. A. Mayer, France; Lieutenant-Colonel N. Pentimalli, Italy; Major-General H. Haraguchi, Japan.

### Ford and Edison Inspect Muscle Shoals

Mr. Ford and his engineers, accompanied by Thomas A. Edison, are making a thorough inspection of the nitrate and water-power projects at Muscle Shoals. One particular object of the investigation is to estimate as exactly as possible the hydro-electric power capacity of the project. Mr. Ford believes 1,000,000 hp. can be developed there and expects to show by data to be collected that his offer to the government of \$28,000,000 for the completion of the Wilson Dam is a liberal one.

### Denver to Hold Industrial Exposition

The Colorado Industrial Exposition is to be held at Denver from Feb. 20 to 25 inclusive, under the auspices of the Colorado Manufacturers and Merchants Association. At least twenty Chambers of Commerce throughout the state will have exhibits together with individual manufacturers from every community. These exhibits will be representative of every character of product manufactured in Colorado.

### Civil Service Examinations

Open competitive examinations for the following positions are announced by the Civil Service Commission. Vacancies exist in the Bureau of Standards.

Technologist; associate technologist; assistant technologist; junior technologist.

Engineer; associate engineer; assistant engineer; junior engineer.

Physicist; associate physicist; assistant physicist; junior physicist.

For technologist, engineer and physicist the salary range is \$2,800 to \$4,000 a year; for associates, \$2,000 to \$2,800; assistants, \$1,500 to \$2,000; juniors, \$1,200 to \$1,500. Applicants for the junior grades will be required to assemble for a written test on Jan. 11, 1922.

It is also stated that the Bureau of Standards is in need of junior aids and laboratory apprentices. The basic pay offered is \$540 a year for apprentices and \$720 to \$840 a year for aids, to which salaries there is added the increase of \$20 a month granted by Congress.

The Bureau of Standards covers a wide field of work in physics, chemistry, engineering and industrial technology, and offers valuable experience to those preparing for those professions. Junior assistants at the Bureau of Standards are given opportunity to continue their college work at the universities in Washington, the courses of which are largely arranged to suit the conveniences of persons in the government service.

### Personal

**CURTIS R. BURNETT**, an official of the American Oil & Supply Co., Newark, N. J., was re-elected president of the Ironbound Manufacturers' Association at its recent annual meeting, for the third consecutive year.

**R. E. EDSELL** has resumed his work at the byproduct coke plant of the McKinney Steel Co., after a leave of absence on account of illness.

**Dr. MORIN FISHBEIN**, editor of the *American Medical Association Journal*, spoke before the Chicago Chemists Club recently on "Chemical Book Plates."

**NELSON B. GASKILL**, of New Jersey, a Republican member of the Federal Trade Commission, succeeded to the chairmanship of the Commission Dec. 1 for a term of one year. Mr. Gaskill, who was vice-chairman during the past year, succeeds to the chairmanship under the rule of the Commission which provides for rotation in the office of chairman among the several commissioners. Mr. Gaskill was appointed to the Commission in December, 1919, to fill an unexpired term caused by the death of John Franklin Fort.

**ARTHUR L. HALVORSEN**, chemical engineer, of Perth Amboy, N. J., has just returned from a 5 weeks' visit to chemical plants in Germany and Norway.

**A. E. HAY**, Canadian sales manager for the Pratt & Lambert Co., Buffalo, N. Y., gave an interesting address before the members of the Buffalo Paint, Oil and Varnish Club, Nov. 25.

**Prof. J. H. MATHEWS**, director of the course in chemistry at the University of Wisconsin, lectured before the department of chemistry at Oberlin College, on Nov. 30, on the subjects "A General Survey of Photochemistry" and "Color Photography." The following evening he spoke before the Cleveland Section of the American Chemical Society on the subject "Photochemistry and Some of Its Research Problems."

**A. V. H. MORY**, formerly associated with Sears, Roebuck & Co. and with Procter & Gamble Co., is now engaged in private practice in Chicago, specializing in chemical organization.

**F. W. NORTHRIDGE, JR.**, assistant manager of the export department of the National Aniline & Chemical Co., has resigned.

**E. D. TWEEDELL**, assistant librarian of the John Crerar Library, spoke before the Chicago Chemists Club recently on the operation and usefulness of a modern scientific library.

**HENRY WIGGLESWORTH**, director of development for the General Chemical Co. and the Allied Dye & Chemical Corporation, has resigned. He will take an extended vacation in Europe.

**Dr. R. W. WOODWARD** has resigned as physicist and chief of the section of mechanical metallurgy of the Bureau of Standards, Washington, D. C., to become chief metallurgist for the Whitney Manufacturing Co., Hartford, Conn.

The United States Potters' Association, East Liverpool, Ohio, has announced that **FRANK P. JUDGE** of the National China Co., Salineville, Ohio, will be elected president of the association at its meeting in Washington, D. C., during the present week, succeeding **B. I. Salisbury** of the Onondaga Pottery Co., Syracuse, N. Y. **Charles F. Goodwin**, East Liverpool, Ohio, will be re-elected secretary-treasurer.

### Current Market Reports

#### The Chemical and Allied Industrial Markets

NEW YORK, Dec. 5, 1921.

The demand for general chemicals during the past week was somewhat irregular, although producers reported a good volume of business from producing channels. Manufacturers of caustic soda and soda ash have not experienced the inquiry they were expecting because of keen competition among first hands. The consuming element had a desire to show more interest in the more important chemicals at prevailing quotations, but producers have shown their desire for new business to a marked extent and buyers in the majority of cases are holding back for new figures. This condition, however, does not hold true for every item, and indications in general point to a gradual increase in the volume of business after the turn of the year. The time is fast approaching for inventory taking, and with this out of the way, all will be ready for a resumption of regular trading. The export business continued to show encouraging developments and additional inquiries were received from various parts of South America and Mexico. Leading factors in the trade are of the opinion that a successful termination of the armament conference will mean a tremendous improvement in our export trade. Importers continued to receive fair-sized shipments of foreign material, but these have had little effect on the spot market, as the big portion has been sent directly into consuming channels on standing contracts. Yellow prussiate of potash, cyanide of soda and bleaching powder have been the most active commodities during the past week. Stocks of these producers appear to be quite scarce, with the demand greatly increased. Chlorate of potash and caustic potash have shown the most weakness in the entire list, with large portions of imported material available at reduced figures.

Producers of 28 per cent *acetic acid* reported sales at 2 $\frac{1}{2}$ c. per lb. The 56 per cent is held at 5 $\frac{1}{2}$ c., while the glacial material varied from 9 $\frac{1}{2}$ @11c. per lb., according to quantity and seller. The market has not shown any new developments during the past month on this product and producers have found their main outlet among consumers holding regular contracts. Most sellers of *formaldehyde* were not eager to quote under 11c. per lb. for spot material in barrels. It is quite possible that several odd lots could be picked up around a fraction below prevailing quotations. The demand has not been very heavy during the interval and dealers were eager to dispose of some of their spot supplies. *Oxalic acid* closed firm at 14 $\frac{1}{2}$ @15c. per lb., according to seller. Holders stated that the inquiry had materially improved since the advance in producers' figures at the works. Market conditions in *tartaric acid* appear easier, and sellers were offering crystals down to 26 $\frac{1}{2}$ c. per lb., with the powdered variety offered at 27c. Goods coming in from abroad were quoted at 25c. per lb. c.i.f. New York. Manufacturers-

prices remained unchanged. Leading producers of *Glaubers salt* quote \$1.25 per 100 lb. for single bags in carload quantities and up to \$1.40 in smaller lots. Barrels were quoted at \$1.40 per 100 lb. in carload lots. Second hands offered occasional lots of imported goods a trifle below producers' quotations. The conditions in the *bleaching powder* market remained quite steady and prominent sellers reported a good inquiry from the consuming trade. Sales were reported at \$2.25 per 100 lb. for large containers and 2½c. per lb. for small drums, f.o.b. works, in carload quantities. Spot material is rather scarce and dealers were firm in their quotations at 2½c. per lb. for large drums. Imported bleach was held around \$2.10 per 100 lb. ex-dock New York. First-hand sales of *sodium sulphite* were reported at \$3.65 @ \$3.75 per 100 lb. in carload lots f.o.b. works. Sales of smaller quantities were made up to 4c. per lb. Prices for light *soda ash* in single bags were quoted around \$1.98 @ \$2.10 per 100 lb., according to seller. Imported material was quoted at \$1.75 @ \$1.80 for 100 lb. Ash in barrels sold down to \$2.35 per 100 lb. The spot market was somewhat dull during the week, as purchasers have shown an inclination toward works material. Manufacturers quote \$1.45 per 100 lb., basis 48 per cent, f.o.b. works, in carload quantities for the single bags. *Prussiate of potash* has improved to a considerable extent and the market is decidedly firmer, with spot offerings very scarce. Sales early in the week were reported at 22@22½c. per lb., with 22½c. reported on inside figure at the close. The demand for spot *caustic soda* was quite irregular and the market closed easy. Occasional offerings were heard around the trade at \$3.90 @ \$4 per 100 lb. Buyers in general were not anxious to pay over \$3.90 for larger quantities. Producers, on the other hand, reported a steady inquiry for material, with frequent sales at prevailing levels. A fair export demand has featured the market during the week. Spot *bichromate of soda* was quoted at 8c. per lb. for small lots. It was intimated that a few odd lots might be purchased a fraction below the regular quotation, although indications were very encouraging for firm prices. Quiet trading in *nitrite of soda* was reported among leading sellers. The market in most directions was quoted at 6½@7c. per lb., while firm business at 6½c. would in all probability be accepted.

#### COAL-TAR PRODUCTS

The export inquiry in the coal-tar products market during the past week was surprisingly encouraging. Japan has come into the market again as a large purchaser of phenol and orders have been around the market for large-sized quantities. The demand from fur dyers has been quite active in the past few days and with an early settlement in garment trade entanglements, this branch of the market should show material strength in prices and demand. Aniline salt showed considerable improvement, as did paranitraniline and naphthalene. There was much surprise expressed at the new prices named by manufacturers of *naphthalene*. The contract quotations for 1922 are given at 6½c. per lb. for the flakes and 7½c. for the balls. This announcement has had a stimulating effect on spot prices and holders were not anxious to quote under 7c. per lb. for spot material. *Benzene* production is gradually coming around and with the increase in steel production the market on this commodity will again become normal. First hands still quote 27@33c. per gal. for future delivery. Spot stocks are exceedingly light and most buyers have been unable to locate any supplies. The *phenol* market has been the leading feature of the coal-tar products division. Exporters with large orders have experienced extreme difficulty in finding prime material at the prices demanded by foreign interests. It seems that spot stocks are the remains of left-over war goods which have been in containers for several years and in the majority of cases have turned into a solid mass of off-colored brown. First hands quote the market at 15c. per lb., with resale material held around 10c. per lb. Government surplus stocks are quoted at 12c. per lb. Supplies of *paranitraniline* in second hands are becoming scarce. Inquiries have materially increased and the market has again become steady at 77@80c. per lb. **Producers of H acid** are offering this product as low as \$1 per lb. but resale lots have sold considerably below this

level. Competition is very keen and some producers have found it impossible to keep up with the present low quotations. The demand is not heavy and orders are mostly for small quantities. Conditions in the *aniline oil* market are somewhat firmer since the scarcity of benzene. The general quotation is 18c. per lb., with 19@20c. asked for smaller lots. Sellers of *diethylaniline* ask \$1 per lb. with several orders recorded down to 95c. per lb. The demand is not very active. The market on *diphenylamine* is steady at 60@65c. per lb., depending upon seller and quantity. Inquiries were decidedly better during the past week.

#### The Chicago Market

CHICAGO, Dec. 1, 1921.

The condition of the chemical market in this district is about the same as has been noted for several weeks. All factors continue to report a good volume of business and are apparently satisfied. It is noticeable that buyers are confining their purchases to parcels that will be consumed by the first of the year and large business can scarcely be expected to materialize until after that time. All indications show that chemical inventories in consumers' hands will be very small this year, which makes the outlook for after the first of the year very bright. Prices for the past two weeks have as a rule held quite firm and there was a noticeable stiffening of quotations in some directions. This is particularly noticeable on imported material, as the situation abroad makes it very difficult to estimate the cost of replacement stocks.

#### GENERAL CHEMICALS

*Caustic soda* is not so firm on spot, although quotations are unchanged at \$4.75 per 100 lb. for the ground 76 per cent and \$4.25 for the solid. These figures could very likely be shaded somewhat for a quantity order. *Soda ash* continues to move in a routine way at \$2.60 per 100 lb. for material in cooperage. *Sal ammoniac* is firm, with supplies none too plentiful. The white granular is held at 8@8½c. for spot stock, and it is doubtful if this could be bettered for ordinary quantities. *Carbon bisulphide* continues firm at 7@7½c. per lb. *Carbon tetrachloride* is also in a firm position, with only moderate supplies available at 10@11c. per lb. *Glycerine* is very firm at the new advance recently announced by refiners, and 15c. per lb. for c.p. material in drums is the prevailing quotation. *Formaldehyde* is quiet, with supplies offered as low as 11c. per lb. for single barrels. *Mercury* is one of the firmest items on the list and only a few small lots were available at \$47 per flask.

*Bichromates* are moving in a routine way and are unchanged at 14c. for the *potash* and 8½@9c. for the *soda*. *Carbonate of potash* is rather dull and one lot of 80-85 per cent calcined was offered at 6c. per lb. *Caustic potash* is moving fairly well at 6½c. per lb. for 88-92 per cent material. *Chlorate of potash* is rather scarce and 8½c. per lb. for the crystals was the best offer noted. The powdered was available in small quantities at 7½c. *Sodium bicarbonate* is plentiful and unchanged at \$2.60 per 100 lb. There was a fair demand for *borax* and supplies were available at 6c. per lb.

The acids are enjoying a fair demand and supplies are plentiful but could scarcely be called large. *Acetic acid* is unchanged at 2½c. for the 28 per cent commercial in barrels and 10@10½c. for the glacial. *Oxalic acid* is moving well at 15½@16½c. per lb. The heavy acids are firm, with *muriatic*, 18 deg., at \$1.50 per 100 lb. in carboys and *nitric* at 6c. *Sulphuric acid* is offered at \$18@\$20 per ton in tank cars f.o.b. works.

#### VEGETABLE OILS

*Linseed oil* has failed to show any marked improvement during the past few days. There is only a fair movement and today's quotations were 77c. per gal. for the boiled and 75c. for the raw, lots of 1 to 3 drums.

#### NAVAL STORES

Naval stores remained in a firm position for the past few days and business was reported as good. *Spirits of turpentine* are enjoying a good demand, and small lots are quoted at 86c. per gal., drum basis. *Rosins* are unchanged as to price and appear to be moving in a fair way.

## The Iron and Steel Market

PITTSBURGH, Dec. 2, 1921.

The finished steel markets continue to exhibit decided dullness, except that in tubular goods there is fully as heavy demand as formerly, while in tin plate there are fairly heavy engagements for first quarter deliveries. What has been suspected in the past few weeks is now made clear, that the usual year-end dullness of the steel market has this year come ahead of time. There is, however, an extenuating circumstance, for it has become evident now that in the past couple of months, when common report was that sales and purchases were only for current shipment, there was a fair volume of contract business done to the end of the year, and this contract business is helping to sustain mill operations at rates far above what would be required to execute the new business being booked from day to day.

In the case of a few commodities a key to the situation mentioned, as to the existence of contracts, is furnished by the yielding of the quoted market price, not to a new low level, but to a price which it is explained was done some time ago. An instance of this is furnished by hoops, bands and hot-rolled strips, which for a while were quoted at 2.25c., base, but are again obtainable at 2c., possibly at a trifle less.

Mill operations have begun to decrease, though the decrease to date is small. Measured in steel ingot output, the decrease is only a few points, as ingot production is estimated at between 40 and 45 per cent of capacity, against an average of 44 per cent in October and a slightly higher rate on Nov. 1. Production of finished steel has probably decreased in greater ratio, since during September and October very considerable tonnages of ingots and semi-finished steel, stocked earlier in the year, were rolled into finished products. Stocks of raw material and intermediate products are now quite thoroughly liquidated, except for large piles of iron ore and perhaps some moderate sized stocks of pig iron.

Of the various branches of the finished steel industry the pipe mills easily lead in point of activity, showing operations of from 60 to 80 per cent. Sheet and tin plate mills come next in point of activity, while wire mills show a moderate rate of operation. Bar, shape, plate and rail mills are relatively inactive.

### STEEL PRICES

The steel market is strongly competitive in practically all branches, though for the time being at least prices are stabilized in tin plate and sheets, at \$4.75 for 100-lb. coke tin plate, 2.25c. for blue annealed sheets, 3c. for black sheets and 4c. for galvanized sheets. The American Sheet & Tin Plate Co. named these sheet prices a week ago, for deliveries through the first quarter, after independents had withdrawn various cut prices below the level indicated. In tubular goods the shading that has been in evidence almost since the reduced lists were issued Sept. 16 is more widespread, but has not gone deeper, an exception being line pipe which apparently has been selling at less than the cost of production. Bars, shapes and plates are quotable in general at a range of 1.50@1.60c.

### PIG IRON AND COKE

The pig-iron market continues very dull, with no material changes in quotable prices. Unfortunately for the market, the failure of prices to exhibit change is ascribed chiefly to the absence of inquiry that would produce competition and an effort on the part of sellers to obtain business. For instance, while the valley market remains quotable at \$20 for bessemer, \$19 for basic and \$20.50 for foundry iron, some furnaces make no secret of the fact that they would welcome an opportunity to shade these prices to get a good-sized order, say one for 5,000 tons.

The Connellsville coke market has grown weaker still, spot furnace having become practically nominal at \$3, while foundry coke rarely sells at above \$4 and draws that price only with difficulty. Production by the merchant ovens in the Connellsville region has decreased fully 25 per cent in the past 5 weeks, while there is no evidence that the rate of consumption has decreased or that production is below consumption now, from which it seems clearly to follow that in the past few weeks a very considerable surplus has been produced.

## General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

	Carlots	Less Carlots
Acetic anhydride.....	lb. \$0.125 - \$0.125	\$0.40 - \$0.45
Acetone.....	lb. 2.75 - 3.00	.13 - .135
Acid, acetic, 28 per cent.....	100 lbs. 5.50 - 5.75	3.25 - 3.50
Acetic, 56 per cent.....	100 lbs. 10.00 - 10.50	6.00 - 6.50
Acetic, glacial, 99½ per cent, carboys, 100 lbs.	1.25 - 1.50	1.00 - 1.00
Boric, crystals.....	lb. 12 - 12½	.13 - .135
Boric, powder.....	lb. 13 - 13½	.14 - .145
Citric.....	lb. 1.25 - 1.50	.45 - .47
Hydrochloric.....	100 lb. 12 - 12½	.12 - .13
Hydrofluoric, 52 per cent.....	lb. .09 - .10	.10 - .12
Lactic, 44 per cent tech.....	lb. .04 - .05	.06 - .07
Lactic, 22 per cent tech.....	lb. 3.25 - 3.50	3.60 - 4.00
Molybdic, C.P. ....	lb. .06 - .06½	.06 - .07
Muriatic, 20 deg. (see hydrochloric).....	lb. .06 - .07	.07 - .075
Nitric, 40 deg. ....	lb. .14 - .15	.15 - .16
Nitric, 42 deg. ....	lb. .13 - .13½	.14 - .145
Oxalic, crya tals.....	lb. 17.00 - 18.00	13.00 - 15.00
Phosphoric, 50 per cent solution.....	lb. 21.00 - 22.00	22.50 - 23.00
Pierie.....	lb. 20 - 25	.27 - .35
Pyrogallic, resublimed.....	lb. 1.25 - 1.50	.19 - 2.00
Sulphuric, 60 deg., tank cars.....	ton 17.00 - 18.00	11.00 - 12.00
Sulphuric, 60 deg., drums.....	ton 21.00 - 22.00	13.00 - 15.00
Sulphuric, 66 deg., tank cars.....	ton 21.00 - 22.00	....
Sulphuric, 66 deg., drums.....	ton 23.00 - 23.50	24.00 - 24.50
Sulphuric, 66 deg., carboys, tank cars.....	ton 31.00 - 32.00	33.00 - 34.00
Sulphuric, fuming, 20 per cent(oleum).....	ton 48.00 - 49.00	50.00 - 55.00
Sulphuric, fuming, 20 per cent(oleum) carboys.....	ton 48.00 - 49.00	50.00 - 55.00
Tannic, U. S. P. ....	lb. .45 - .48	.50 - .55
Tannic (tech.) ....	lb. .26 - .27	.26 - .26½
Tartaric, imported crystals.....	lb. 2.27 - 2.28	.28 - .35
Tartaric acid, imported, powdered.....	lb. 1.10 - 1.20	1.20 - 1.20
Tungstic, per lb. of WO <sub>3</sub> .....	gal. 4.65 - 5.00	....
Alcohol, Ethyl.....	gal. 37 - 38	....
Alcohol, Methyl (see methanol).....	gal. 35 - 36	....
Alcohol, denatured, 188 proof.....	gal. 35 - 36	....
Alcohol, denatured, 190 proof.....	gal. 35 - 36	....
Alum, ammonia, lump.....	lb. .03 - .03½	.04 - .04½
Alum, potash, lump.....	lb. .03 - .04	.04 - .04½
Alum, chrome lump.....	lb. .08 - .08½	.08 - .09
Aluminum sulphate, commercial.....	lb. .01 - .02	.02 - .02½
Aluminum sulphate, iron free.....	lb. .02 - .02½	.03 - .03½
Aqua ammonia, 26 deg., drums(750 lb.)	lb. .07 - .07½	.08 - .08½
Ammonia, anhydrous, cyl.(100-150 lb.)	lb. .31 - .32	.33 - .35
Ammonium carbonate, powder.....	lb. .07 - .07½	.08 - .09
Ammonium chloride, granular (white salammoniac).....	lb. .07 - .07½	.07 - .07½
Ammonium chloride, granular (gray salammoniac).....	lb. .07 - .07½	.07 - .07½
Ammonium nitrate.....	lb. 2.40 - 2.65	....
Amylacetate tech. ....	gal. .06 - .06½	.07 - .07½
Arsenic oxide, (white arsenic) powdered	lb. 12 - 12½	.12 - .13
Arsenic sulphide, powdered (red arsenic).....	lb. 20 - 21	.22 - .23
Barium chloride.....	lb. .06 - .07	.07 - .08
Barium dioxide (peroxide).....	lb. .04 - .04½	.04 - .05
Barium nitrate.....	lb. 1.40 - 1.50	....
Barium sulphate (precip.) (blanc fixe).....	lb. 15 - 16	....
Bleaching powder (see calc. hypochlorite).....	lb. 91 - 95	....
Blue vitriol (see copper sulphate).....	lb. .11 - .12	.12 - .12½
Borax (see sodium borate).....	lb. .60 - .65	.75 - .75
Bromine.....	lb. 27 - 28	.28 - .30
Calcium acetate.....	100 lbs. 1.75 - 2.00	.05 - .05½
Calcium carbide.....	lb. .04 - .04½	.02 - .02½
Calcium chloride, fused, lump.....	ton 23.50 - 24.00	24.50 - 25.50
Calcium chloride, granulated.....	lb. .01 - .02	.02 - .02½
Calcium hypochloride(bleach'g powder)100 lb.	2.75 - 2.85	2.90 - 3.50
Calcium peroxide.....	lb. -	1.40 - 1.50
Calcium phosphate, tribasic.....	lb. -	.91 - .95
Campbell's.....	lb. -	....
Carbon bisulphide.....	lb. .06 - .06½	.07 - .07½
Carbon tetrachloride, drums.....	lb. .10 - .10½	.11 - .12
Carbonyl chloride, (phosgene).....	lb. -	.60 - .75
Caustic potash (see potassium hydroxide).....	lb. -	....
Caustic soda (see sodium hydroxide).....	lb. -	....
Chlorine, gas, liquid-cylinders(100 lb.)	lb. .08 - .09	.09 - .10
Chloroform.....	lb. -	.40 - .43
Cobalt oxide.....	lb. -	2.00 - 2.10
Copperas (see iron sulphate).....	lb. -	....
Copper carbonate, green precipitate.....	lb. .19 - .19½	.20 - .21
Copper cyanide.....	lb. -	.50 - .62
Copper sulphate, crystals.....	lb. .05 - .05½	.05 - .06
Cream of tartar (see potassium bitartrate).....	lb. -	....
Epsom salt (see magnesium sulphate).....	lb. -	....
Ethyl Acetate Com. 85%.....	gal. 70 - 80	....
Ethyl Acetate pure (acetic ether, 95% to 100%).....	gal. 95 - 112	....
Formaldehyde, 40 per cent.....	lb. 104 - 111	2.50 - 3.00
Fusel oil, ref. ....	gal. 1.50 - 1.75	....
Fusel oil, crude.....	gal. -	....
Glauber's salt (see sodium sulphate).....	lb. -	....
Glycerine, C. P. drums extra.....	lb. -	14½ - 15
Iodine, resublimed.....	lb. -	3.50 - 3.60
Iron oxide, red.....	lb. -	.12 - .18
Iron sulphate (copperas).....	ton 18.00 - 19.00	20.00 - 23.00
Lead acetate.....	lb. 15 - 15½	.15½ - .16½
Lead arsenate, powd. ....	lb. -	.15 - .20
Lead nitrate.....	lb. -	.08 - .09
Litharge.....	lb. -	....
Lithium carbonate.....	lb. .08 - .08½	.140 - 1.50
Magnesium carbonate, technical.....	lb. -	1.10 - 1.25
Magnesium sulphate, U. S. P. 100 lb.	2.50 - 2.75	.66 - .68
Magnesium sulphate, technical.....	lb. -	.70 - .72
Methanol, 95%.....	gal. -	....
Methanol, 97%.....	gal. -	....
Nickel Salt, double.....	lb. -	.12 - .12½
Nickel Salt, single.....	lb. -	.14 - .14½
Phosgene (see carbonyl chloride).....	lb. -	....
Phosphorus, red.....	lb. 45 - 46	.47 - .50
Phosphorus, yellow.....	lb. -	.32 - .35
Potassium bichromate.....	lb. 11 - 11½	.11½ - .12

	Carlots	Less Carlots
Potassium bitartrate (cream of tartar)	lb. \$3.00 - \$3.00	\$0.28 - \$0.30
Potassium bromide, granular	lb. .15 - .20	.15 - .20
Potassium carbonate, U. S. P.	lb. .15 - .16	.17 - .20
Potassium carbonate, 80-85%	lb. .04 - .041	.05 - .06
Potassium chlorate, crystals	lb. .05 - .06	.06 - .12
Potassium cyanide	lb. .40 - .45	.40 - .45
Potassium hydroxide (caustic potash)	lb. .05 - .06	.06 - .08
Potassium iodide	lb. .20 - .25	.20 - .25
Potassium nitrate	lb. .07 - .071	.08 - .09
Potassium permanganate	lb. .17 - .18	.18 - .21
Potassium prussiate, red	lb. .28 - .29	.29 - .30
Potassium prussiate, yellow	lb. .22 - .221	.23 - .231
Rochelle salts (see sodium potas tartrate)		-
Salammoniac (see ammonium chloride)		-
Salt cake (see sodium carbonate)	ton -	19.00 - 21.00
Salt cake (bulk)	ton -	1.10 - 1.20
Silver cyanide	oz. -	.45 - .46
Soda ash, light	100 lb. 1.90 - 2.00	2.10 - 2.40
Soda ash, dense	100 lb. 2.25 - 2.30	2.35 - 2.60
Sodium acetate	lb. .04 - .041	.041 - .05
Sodium bicarbonate	100 lb. 2.00 - 2.25	2.50 - 2.75
Sodium bichromate	lb. .08 - .081	.081 - .081
Sodium bisulphite (nitre cake)	ton 5.00 - 5.25	5.50 - 6.50
Sodium bisulphite powdered, U.S.P.	lb. .04 - .05	.051 - .06
Sodium borate (borax)	lb. .05 - .06	.061 - .07
Sodium carbonate (mild soda)	100 lb. 1.80 - 1.90	2.00 - 2.20
Sodium chloride	lb. .07 - .071	.08 - .081
Sodium cyanide	lb. .28 - .281	.29 - .30
Sodium fluoride	lb. .11 - .12	.12 - .14
Sodium hydroxide (caustic soda)	100 lb. 3.90 - 4.00	4.05 - 4.50
Sodium hyposulphite	lb. -	.031 - .031
Sodium nitrite	lb. .06 - .07	.071 - .071
Sodium peroxide, powdered	lb. .25 - .26	.27 - .30
Sodium phosphate, dibasic	lb. .04 - .041	.041 - .051
Sodium potassium tartrate (Rochelle salts)	lb. -	.21 - .24
Sodium prussiate, yellow	lb. .14 - .141	.15 - .151
Sodium silicate, solution (40 deg.)	100 lb. 1.00 - 1.05	1.10 - 1.30
Sodium silicate, solution (60 deg.)	100 lb. 2.30 - 2.40	2.45 - 3.00
Sodium sulphate, crystals (Glauber's salt)	100 lb. 1.30 - 1.50	1.60 - 2.00
Sodium sulphide, f.s. sed. 60-62 per cent (cone)	lb. .04 - .041	.05 - .051
Sodium sulphite, crystals	lb. .03 - .031	.04 - .041
Strontium nitrate, powdered	lb. .13 - .14	.14 - .15
Sulphur chl ride, red	lb. .06 - .061	.061 - .07
Sulphur, crude	ton 18.00 - 20.00	-
Sulphur dioxide, liquid, cylinders extra	lb. .08 - .081	.09 - .10
Sulphur (sublimed), flour	100 lb. -	2.25 - 3.10
Sulphur, roll (brimstone)	100 lb. -	2.00 - 2.75
Tin bichloride	lb. .09 - .091	.091 - .10
Tin oxide	lb. -	.37 - .38
Zinc carbonate, precipitate	lb. .16 - .161	.17 - .17
Zinc chloride, gran.	lb. .09 - .091	.091 - .10
Zinc cyanide	lb. .42 - .44	.45 - .47
Zinc dust	lb. .111 - .111	.111 - .121
Zinc oxide, XX	lb. .071 - .071	.08 - .09
Zinc sulphate	100 lb. 3.00 - 3.25	3.30 - 3.50

**Coal-Tar Products**

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude	lb. \$1.10 - \$1.15
Alpha-naphthol, refined	lb. 1.25 - 1.30
Alpha-naphthylamine	lb. .30 - .32
Aniline oil, drums extra	lb. .18 - .20
Aniline salts	lb. .24 - .26
Anthracene, 80% in drums (100 lb.)	lb. .75 - 1.00
Benzaldehyde U.S.P.	lb. 1.35 - 1.45
Benzidine, base	lb. .90 - 1.00
Benzidine sulphate	lb. .75 - .85
Benzoic acid, U.S.P.	lb. .62 - .65
Benzoate of soda, U.S.P.	lb. .52 - .55
Benzene, pure, water-white, in drums (100 gal.)	gal. .27 - .32
Benzene, 90%, in drums (100 gal.)	gal. .25 - .28
Benzyl chloride, 95-97%, refined	lb. .25 - .27
Benzyl chloride, tech.	lb. .20 - .23
Beta-naphthol benzoate	3.75 - 4.00
Beta-naphthol, sublimed	lb. .70 - .75
Beta-naphthol, tech.	lb. .30 - .34
Beta-naphthylamine, sublimed	lb. 1.75 - 1.85
Cresol, U. S. P., in drums (100 lb.)	lb. .15 - .16
Ortho-cresol in drums (100 lb.)	lb. .24 - .26
Cresylic acid, 97-99%, straw color, in drums	gal. .70 - .80
Cresylic acid, 75-97%, dark, in drums	gal. .65 - .70
Cresylic acid, 50%, first quality, drums	gal. .45 - .50
Dichlorobenzene	lb. .06 - .09
Diethylylaniline	lb. .95 - 1.10
Dimethylylaniline	lb. .45 - .60
Dinitrobenzene	lb. .23 - .27
Dinitrochlorobenzene	lb. .20 - .25
Dinitronaphthalene	lb. .30 - .35
Dinitrophenol	lb. .35 - .40
Dinitrotoluene	lb. .25 - .30
Dip oil, 25%, ear lots, in drums	gal. .30 - .35
Diphenylamine	lb. .60 - .70
H-acid	lb. 1.00 - 1.10
Meta-phenylenediamine	lb. 1.10 - 1.15
Monochlorobenzene	lb. .12 - .14
Monoethylaniline	lb. 1.65 - 1.70
Naphthalene, crushed, in bbls.	lb. .07 - .08
Naphthalene, flake	lb. .07 - .08
Naphthalene, balls	lb. .08 - .091
Naphthionic acid, crude	lb. .70 - .75
Nitrobenzene	lb. .12 - .15
Nitro-naphthalene	lb. .30 - .35
Nitro-toluene	lb. .15 - .17
Ortho-aminophenol	lb. 3.00 - 3.10
Ortho-dichlorobenzene	lb. .15 - .20
Ortho-nitro-phenol	lb. .77 - .80
Ortho-nitro-toluene	lb. .15 - .20
Ortho-toluidine	lb. .20 - .25
Para-amidophenol, base	lb. 1.40 - 1.45
Para-amidophenol, HCl	lb. 1.70 - 1.80
Para-dichlorobenzene	lb. .12 - .15
Paranitroaniline	lb. .75 - .80
Para-nitrotoluene	lb. .80 - .85
Para-phenylenediamine	lb. 1.70 - 1.75
Para-toluidine	lb. 1.25 - 1.40
Phthalic anhydride	lb. .40 - .50

Carlots	Less Carlots	Prices based on original packages in large quantities.
Phenol, U. S. P., drums	lb. .10 — .15	gal. 2.00 — 3.50
Pyridine	lb. 1.50 — 1.60	gal. 2.00 — 2.25
Resorcinol, technical	lb. .20 — .21	gal. .22 — .23
Salicylic acid, tech., in bbls.	lb. .70 — .72	gal. .25 — .28
Salol	lb. .14 — .16	gal. .27 — .30
Solvent naphtha, water-white, in drums, 100 gal.	gal. 1.30 — 1.35	gal. .43 — .45
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal. .25 — .28	gal. .28 — .31
Sulphanilic acid, crude	lb. .40 — .45	gal. .40 — .45
Tolidine	lb. .21 — .21	gal. .45 — .55
Toluidine, mixed	lb. .21 — .21	gal. .33 — .35
Toluene, in tank cars	gal. .30 — .30	gal. .30 — .30
Toluene, in drums	gal. .30 — .30	gal. .30 — .30
Xylylides, drums, 100 gal.	gal. .30 — .30	gal. .30 — .30
Xylene, pure, in drums	gal. .30 — .30	gal. .30 — .30
Xylene, pure, in tank cars	gal. .30 — .30	gal. .30 — .30
Xylene, commercial, in drums, 100 gal.	gal. .30 — .30	gal. .30 — .30
Xylene, commercial, in tank cars	gal. .30 — .30	gal. .30 — .30

**Waxes**

Prices based on original packages in large quantities.	
Bayberry Wax	lb. \$0.20 — \$0.21
Beeswax, refined, dark	lb. .24 — .25
Beeswax, refined, light	lb. .28 — .30
Beeswax, white pure	lb. .34 — .38
Candellila wax	lb. .24 — .24
Carnauba, No. 1	lb. .45 — .46
Carnauba, No. 2, North Country	lb. .23 — .23
Carnauba, No. 3, North Country	lb. .14 — .14
Japan	lb. .21 — .21
Montan, crude	lb. .04 — .04
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb. .04 — .04
Paraffine waxes, crude, scale 124-126 m.p.	lb. .03 — .03
Paraffine waxes, refined, 118-120 m.p.	lb. .04 — .04
Paraffine waxes, refined, 125 m.p.	lb. .04 — .04
Paraffine waxes, refined, 128-130 m.p.	lb. .04 — .04
Paraffine waxes, refined, 133-135 m.p.	lb. .05 — .05
Paraffine waxes, refined, 135-137 m.p.	lb. .05 — .06
Stearic acid, single pressed	lb. .09 — .09
Stearic acid, double pressed	lb. .09 — .09
Stearic acid, triple pressed	lb. .10 — .10

**Naval Stores**

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.	
Rosin B-D, bbl.	280 lb. \$5.55 — 5.60
Rosin E-I,	280 lb. 5.60 — 5.65
Rosin K-N,	280 lb. 6.20 — 6.75
Rosin W. G.-W. W.	280 lb. 7.00 — 7.25
Wood rosin, bbl.	280 lb. 6.25 —
Spirits of turpentine	gal. .80 —
Wood turpentine, steam dist.	gal. .78 —
Wood turpentine, dest. dist.	gal. .76 —
Pine tar pitch, bbl.	200 lb. .6.00 —
Tar, kiln burned, bbl. (500 lb.)	500 lb. 10.50 —
Retort tar, bbl.	gal. .36 —
Rosin oil, first run	gal. .39 —
Rosin oil, second run	gal. .46 —
Rosin oil, third run	gal. .46 —
Pine oil, steam dist., sp.gr. 0.930-0.940	gal. \$1.90 —
Pine oil, pure, dest. dist.	gal. 1.50 —
Pine tar oil, ref., sp.gr. 1.025-1.035	gal. .46 —
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.	gal. .35 —
Pine tar oil, double ref., sp.gr. 0.965-0.990	gal. .75 —
Pine tar, ref., thin, sp.gr. 1.080-1.960	gal. .35 —
Turpentine, crude, sp.gr. 0.900-0.970	gal. 1.25 —
Hardwood oil, f.o.b. Mich., sp.gr. 0.960-0.990	gal. .35 —
Pinewood creosote, ref.	gal. .52 —

**Solvents**

73-76 deg., steel bbls. (85 lb.)	gal. \$0.37 —
70-72 deg., steel bbls. (85 lb.)	gal. .35 —
68-70 deg., steel bbls. (85 lb.)	gal. .34 —
V. M. and P. naphtha, steel bbls. (85 lb.)	gal. .23 —

**Fertilizers**

Ammonium sulphate, bulk and d. bags.	100 lb. \$2.30 — 2.90
Blood, dried, f.o.b., N. Y.	unit 4.00 —
Bone, 3 and 50, ground, raw	ton 30.00 — 32.00
Fish scrap, dom., dried, f.o.b. works	unit 2.90 — 3.00
Nitrate soda	100 lb. 2.30 — 2.35
Tankage, high grade, f.o.b. Chicago	unit 2.75 — 3.00
Phosphate rock, f.o.b. mines, Florida pebble, 68-72 p.c.	ton 4.50 — 6.50
Tennessee, 78-80 p.c.	ton 8.50 — 9.00
Potassium muriate, 80 p.c.	ton 37.00 — 40.00
Potassium sulphate	unit .90 — 1.00

**Crude Rubber**

Para-Upriver fine	lb. \$0.21 — .22
Upriver coarse	lb. .13 — .14
Upriver caucho ball	lb. .13 — .13
Plantation—First latex crepe	lb. .17 — .18
Ribbed smoked sheets	lb. .17 — .18
Brown crepe, thin, clean	lb. .15 — .16
Amber crepe No. 1	lb. .17 — .17

**Oils****VEGETABLE**

The following prices are f.o.b. New York for carload lots.	
Castor oil, No. 3, in bbls.	lb. \$0.10 — \$0.10
Castor oil, AA, in bbls.	lb. .11 — .12
China wood oil, in bbls. (f.o.b. Pac. coast)	lb. .13 — .13
Cocoanut oil, Ceylon grade, in bbls.	lb. .09 — .09
Cocoanut oil, Ceylon grade, in bbls.	lb. .10 — .10
Corn oil, crude, in bbls.	lb. .08 — .08
Cottonseed oil, crude (f. o. mill)	lb. .07 — .07
Cottonseed oil, summer yellow	lb. .08 — .09
Cottonseed oil, winter yellow	lb. .09 — .09

Linseed oil, raw, car lots (domestic)	gal.	.65	—	.66
Linseed oil, raw, tank cars (domestic)	gal.	.60	—	.61
Linseed oil, in 5-bbl lots (domestic)	gal.	.68	—	.69
Olive oil, Denatured	gal.	\$1.15	—	\$1.20
Palm, Lagos	lb.	.075	—	.072
Palm, Niger	lb.	.064	—	.064
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.08	—	.08
Peanut oil, refined in bbls.	lb.	.114	—	.114
Rapeseed oil, refined in bbls.	lb.	.83	—	.84
Rapeseed oil, blown, in bbls.	lb.	.88	—	.90
Soya bean oil (Manchurian), in bbls. N. Y.	lb.	.08	—	—
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.075	—	—
<b>FISH</b>				
Light pressed menhaden	gal.	\$0.40	—	—
Yellow bleached menhaden	gal.	.42	—	—
White bleached menhaden	gal.	.45	—	—
Blown menhaden	gal.	.48	—	—

**Miscellaneous Materials**

<b>All f.o.b. New York Unless Otherwise Stated</b>				
Barytes, ground, white, f.o.b. Kings Creek, S. C.	net ton	\$23.50	—	28.00
Barytes, ground, off color, f.o.b. Kings Creek	net ton	15.00	—	17.00
Barytes, crude, 85%@94% ba., Kings Creek	net ton	10.00	—	12.00
Barytes, floated, f.o.b. St. Louis	net ton	23.00	—	24.00
Barytes, crude, first grade, Missouri	net ton	7.00	—	—
Blane fine, dry	lb.	.04	—	.04
Blane fine, pulp	net ton	45.00	—	55.00
Casine	lb.	.15	—	.16
Chalk, Precipitated, domestic, extra light	lb.	.04	—	.05
Chalk, Precipitated, domestic, light	lb.	.04	—	.04
Chalk, Precipitated, domestic, heavy	lb.	.03	—	.04
Chalk, Precipitated, English, extra light	lb.	.04	—	.05
Chalk, Precipitated, English, light	lb.	.04	—	.05
Chalk, Precipitated, English, dense	lb.	.04	—	.04
China clay (kaolin) crude, f.o.b. mines, Georgia	net ton	6.50	—	8.50
China clay (kaolin) washed, f.o.b. Georgia	net ton	9.00	—	10.00
China clay (kaolin) powdered, f.o.b. Georgia	net ton	13.00	—	20.00
China clay (kaolin) crude f.o.b. Virginia points	net ton	8.00	—	12.00
China clay (kaolin) ground, f.o.b. Virginia points	net ton	13.00	—	20.00
China clay (kaolin) imported, lump	net ton	12.00	—	20.00
China clay (kaolin) imported, powdered	net ton	25.00	—	30.00
Feldspar, crude, f.o.b. Maryland and North Carolina points	net ton	5.00	—	7.50
Feldspar, crude, f.o.b. Maine	net ton	7.50	—	10.00
Feldspar, ground, f.o.b. Maine	net ton	21.00	—	23.00
Feldspar, ground, f.o.b. North Carolina	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. N. Y. State	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. Baltimore	net ton	27.00	—	30.00
Fuller's earth, f.o.b. Mines	net ton	16.00	—	17.00
Fuller's earth, granular, f.o.b. Pa.	net ton	15.00	—	18.00
Fuller's earth, powdered, f.o.b. Fla.	net ton	18.00	—	—
Fuller's earth, imported, powdered	net ton	24.00	—	27.00
Graphite, Ceylon lump, fist quality	lb.	.06	—	.07
Graphite, Ceylon chip	lb.	.04	—	.05
Graphite, high grade amorphous crude	lb.	.004	—	.02
Kieselguhr, f.o.b. mines, Cal.	per ton	40.00	—	—
Kieselguhr, f.o.b. N. Y.	per ton	55.00	—	60.00
Magnesite, calcined	per ton	50.00	—	65.00
Pumice stone, imported	lb.	.03	—	.40
Pumice stone, domestic, lump	lb.	.05	—	.05
Pumice stone, domestic, ground	lb.	.06	—	.07
Quartz (acid tower) first to head, f.o.b. Baltimore	net ton	—	—	10.00
Quartz (acid tower) 1/2@2 in., f.o.b. Baltimore	net ton	—	—	14.00
Quartz (acid tower) rice, f.o.b. Baltimore	net ton	—	—	17.00
Quartz, lump, f.o.b. North Carolina	net ton	5.00	—	7.50
Shellac, orange fine	lb.	.68	—	.70
Shellac, orange superfine	lb.	.78	—	.80
Shellac, A. C. garnet	lb.	.58	—	.60
Shellac, T. N.	lb.	.68	—	.70
Soapstone	ton	12.00	—	15.00
Sodium chloride	long ton	12.50	—	13.00
Talc, paper-making grades, f.o.b. Vermont	ton	11.00	—	18.00
Talc, roofing grades, f.o.b. Vermont	ton	8.50	—	13.00
Talc, rubber grades, f.o.b. Vermont	ton	11.00	—	18.00
Talc, powdered, Southern, f.o.b. cars	ton	7.50	—	11.00
Talc, imported	ton	30.00	—	40.00
Talc, California talcum powder grade	ton	18.00	—	25.00

**Refractories**

Bauxite brick, 56% Al, f.o.b. Pittsburgh	per ton	\$50.00	—	—
Carborundum refractory brick, 9-in. { less than carlot	carload lots	1,000	—	1250.00
Chrome brick, f.o.b. Eastern shipping points	—	1,000	—	1100.00
Chrome cement, 40-45% Cr <sub>2</sub> O <sub>3</sub>	net ton	52—55	—	—
Chrome cement, 40-45% Cr <sub>2</sub> O <sub>3</sub> , sacks, in car lots, f.o.b. Eastern shipping points	net ton	30—32	—	—
Fireclay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania	net ton	33—35	—	—
Fireclay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania	1,000	35—40	—	—
Fireclay brick, 2nd quality, 9-in. shapes, f.o.b. Ohio and Kentucky works	1,000	30—35	—	—
Magnesite brick, 9-in. straight	net ton	65—70	—	—
Magnesite brick, 9-in. arches, wedges and keys	net ton	77	—	—
Magnesite brick, soaps and splits	net ton	98	—	—
Silica brick, 9-in. sizes, f.o.b. Chicago district	1,000	40—42	—	—
Silica brick, 9-in. sizes, f.o.b. Birmingham district	1,000	42—45	—	—
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa.	1,000	35—38	—	—

**Ferro-Alloys**

All f.o.b. Works

Ferrocarbon-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.	net ton	\$200.00	—	225.00
Ferrochrome per lb. of Cr. contained, 6-8%	lb.	.11	—	—
Ferrochrome, per lb. of Cr. contained, 4-6%	lb.	.11	—	12
Ferromanganese, 76-80% Mn, domestic	gross ton	58.00	—	60.00
Ferromanganese, 76-80% Mn, English & German	gross ton	58.00	—	59.00
Spiegeleisen, 18-22% Mn	gross ton	25.00	—	27.00
Ferromolybdenum, 50-60% Mo, per lb. of Mo	lb.	2.25	—	—
Ferrosilicon, 10-15%	gross ton	38.00	—	40.00
Ferrosilicon, 50%	gross ton	57.00	—	59.00
Ferrosilicon, 75%	gross ton	120.00	—	125.00
Ferrotungsten, 70-80%, per lb. of contained W	lb.	.40	—	.45
Ferouranium, 35-50% U, per lb. of U content	lb.	6.00	—	—
Ferrovaniadium, 30-40% per lb. of contained V	lb.	4.25	—	4.50

**CHEMICAL AND METALLURGICAL ENGINEERING****Ores and Semi-finished Products**

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al content	net ton	\$8.00	—	\$10.00
Chrome ore, Calif. concentrates, 50% min.	ton	22.00	—	23.00
Cr <sub>2</sub> O <sub>3</sub>	ton	22.00	—	23.00
Chrome ore, 50% Cr <sub>2</sub> O <sub>3</sub> , f.o.b. Atlantic seaboard	ton	22.00	—	23.00
Coke, foundry, f.o.b. ovens	net ton	4.25	—	4.50
Coke, furnace, f.o.b. ovens	net ton	3.25	—	3.50
Fluorspar, gravel, f.o.b. mines, New Mexico	net ton	12.00	—	—
Fluorspar, standard, domestic washed gravel	ton	20.00	—	22.00
Kentucky and Illinois mines	lb.	.011	—	.013
Ilmenite, 52% TiO <sub>2</sub> , per lb. ore	lb.	.23	—	.24
Manganese ore, 50% Mn, e.i.f. Atlantic seaport	unit	55.00	—	60.00
Molybdenite, 85% MoS <sub>2</sub> , per lb. of MoS <sub>2</sub> , N. Y.	lb.	.45	—	.50
Monazite, per unit of ThO <sub>2</sub> , e.i.f. Atlantic seaport	unit	30.00	—	—
Pyrites, Spanish, fines, e.i.f. Atlantic seaport	unit	.12	—	.12
Pyrites, Spanish, furnace size, e.i.f. Atlantic seaport	unit	.13	—	.13
Pyrites, domestic, fines, f.o.b. mines Ga.	unit	.11	—	.12
Rutile, 95% TiO <sub>2</sub> , per lb. ore	lb.	.15	—	—
Tungsten, scheelite, 60% WO <sub>3</sub> and over, per unit of WO <sub>3</sub> (nominal)	unit	2.50	—	2.75
Tungsten, Wolframite, 60% WO <sub>3</sub> and over, per unit of WO <sub>3</sub> , N. Y. C.	unit	2.75	—	3.00
Uranium ore (carmotite) per lb. of U <sub>3</sub> O <sub>8</sub>	lb.	1.25	—	1.75
Uranium oxide, 96% per lb. contained U <sub>3</sub> O <sub>8</sub>	lb.	2.25	—	2.50
Vanadium pentoxide, 99%	lb.	12.00	—	14.00
Vanadium ore, per lb. of V <sub>2</sub> O <sub>5</sub> contained	lb.	1.00	—	—
Zircon, washed, iron free, f.o.b. Pablo, Florida	lb.	.04	—	.13

**Non-Ferrous Metals**

New York Markets

Copper, electrolytic	lb.	13.625	—	—
Aluminum, 98 to 99 per cent	24.50@25.00	—	—	—
Antimony, wholesale lots, Chinese and Japanese	4.60	—	—	—
Nickel, ordinary (ingot)	41.00	—	—	—
Nickel, electrolytic	44.00	—	—	—
Monel metal, shot and blocks	35.00	—	—	—
Monel metal, ingots	38.00	—	—	—
Monel metal, sheet bars	40.00	—	—	—
Tin, 5-ton lots, Straits	29.75	—	—	—
Lead, New York, spot	4.70	—	—	—
Lead, E. St. Louis, spot	4.35	—	—	—
Zinc, spot, New York	5.10@5.15	—	—	—
Zinc, spot, E. St. Louis	4.65@4.70	—	—	—

**OTHER METALS**

Silver (commercial)	oz.	\$0.66	—	—
Cadmium	lb.	1.00—1.25	—	—
Bismuth (500 lb. lots)	lb.	1.50@1.55	—	—
Cobalt	lb.	3.00@3.25	—	—
Magnesium (f.o.b. Philadelphia)	lb.	1.25	—	—
Platinum	oz.	80.00	—	—
Iridium	oz.	150.00@170.00	—	—
Palladium	oz.	55.00—60.00	—	—
Mercury	75 lb.	43.00—44.00	—	—

Copper sheets, hot rolled

Copper bottoms

Copper rods

High brass wire

High brass rods

Low brass wire

Brazed brass tubing

Brazed bronze tubing

Seamless copper tubing

Seamless high brass tubing

Copper, heavy and crucible

Copper, heavy and wire

Copper, light and bottoms

Lead, heavy

Lead, ten

Brass, heavy

Brass, light

No. 1 yellow brass turnings

Zinc

The following base prices per 100 lb. are for structural shapes 3 in. by 1 in. and larger, and plates 1 in. and heavier, from jobbers' warehouses in the cities named:

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by 1 in. and larger, and plates 1 in. and heavier, from jobbers' warehouses in the cities named:

# Industrial

## Financial, Construction and Manufacturers' News

### Construction and Operation

#### Alabama

BIRMINGHAM—The Birmingham Paper Co. has awarded a contract to C. M. Allen & Son, Birmingham, for the construction of a 1-story plant, 100 x 190 ft., for the manufacture of corrugated paper boxes and kindred products, estimated to cost about \$75,000. Of this amount, approximately \$40,000 will be used for the machinery installation. T. M. McClellan is president.

GADSDEN—The Gadsden Clay Products Co. has commenced work on its extension and improvement program, to include the installation of three down-draft kilns, with capacity of about 150,000 bricks; drying plant of waste-heat type, and other department extensions. It is proposed to develop an output of about 40,000 bricks per day. Gordon Hood is treasurer and general manager.

#### Connecticut

WINDSOR LOCKS—The J. N. L. Smythe Co., 32-34 South Sixth St., Philadelphia, Pa., manufacturer of paper products, has acquired the plant and business of the Windsor Locks Paper Mills, Windsor Locks. The new owner plans for extensions in the mill to double the present capacity.

#### Florida

EUSTIS—Adam J. Walz, Fort Mason, near Eustis, is organizing a company to establish a local plant for the manufacture of pressed bricks. Steam-operated presses, drying apparatus and other equipment will be installed.

#### Illinois

CICERO—M. L. Barrett & Co., 233 West Lake St., Chicago, manufacturer of essential oils, will soon commence the erection of a new plant at Cicero, contract for which recently has been awarded to the Kniskern Co., 149 South Dearborn St., Chicago. It will consist of two 1-story buildings, and is estimated to cost about \$100,000, including equipment. H. N. Mulder, Room 1702, 149 South Dearborn St., Chicago, is architect.

#### Indiana

INDIANAPOLIS—The Beveridge Paper Co. has tentative plans under consideration for the erection of a new building at its plant. It is proposed to begin work next spring. H. L. Beveridge is president.

#### Kentucky

SOMERSET—The Kentucky Coal & Electro Chemical Co. has preliminary plans under way for the erection of a local chemical manufacturing plant, comprising a group of buildings, estimated to cost about \$500,000, including machinery. The Associated Engineering Co., Somerset, is engineer.

LOUISVILLE—The Dosch Chemical Co. has acquired a local plant totaling over 15 acres of floor space, for the establishment of a new works for the manufacture of lime sulphur, rubber sulphur, sulphite solutions and other chemical products. A large department will be operated for the manufacture of insecticides, as well as for the production of machinery for spraying, dusting, etc., with chemical solutions. The machinery and equipment installation at the plant is estimated to cost in excess of \$200,000. Theodore Dosch is president of the company.

#### Louisiana

BOGALUSA—The Bogalusa Paper Co. is planning for the construction of a large addition to its local paper mills, erected several years ago and representing an investment of about \$2,000,000. The proposed extension will duplicate, in part, the present mill and is estimated to cost close to \$1,000,000, with machinery. W. H. Sullivan is president.

#### Maryland

BALTIMORE—The Adamantex Brick Co., recently organized with a capital of \$1,000,000, has acquired property on the Sulphur

Springs Road, Towson, totaling about 25 acres of land, as a site for the erection of its proposed plant for the manufacture of sand-cement bricks. It is proposed to provide buildings and equipment for an initial daily production of about 200,000 bricks. The company is represented by Blum & Makover, Equitable Bldg. L. F. Ducker is president.

#### Massachusetts

FITCHBURG—The Crocker-Burbank Co., manufacturer of paper products, has perfected plans for extensions and improvements in its mill, estimated to cost in the neighborhood of \$100,000, including machinery which will be installed.

PEABODY—Budgett & Harrigan, manufacturers of leather products, have acquired the local plant of the Formal Leather Co., for the establishment of a works for the production of chrome white leather, with daily output to approximate 200 dozen skins. The company will also continue operations at its plant in the Ingraham Bldg., and plans to increase the facilities of this factory.

#### Michigan

PLAINWELL—The Otsego Angle Steel Co. has construction under way on a 1-story plant, 40 x 200 ft., and plans for the early occupancy of the structure.

RIVERROUGE—The American Brick & Tile Co., recently organized, has acquired a tract of land totaling about 16 acres, adjoining the plant of the Ewing Bolt & Screw Co., with about 600 ft. of frontage on the Rouge River. It will be used as a site for the erection of a brick- and tile-manufacturing plant, with facilities to provide for the employment of about 500 operatives at the start. Preliminary plans are under way.

#### Missouri

FERGUSON—The Republic Photographic Co., Kansas City, Mo., is perfecting plans for the early erection of its proposed plant at Ferguson, and will soon break ground for different buildings. It will be equipped for the manufacture of sensitized paper specialties. The main building will be 78 x 160 ft., with chemical laboratory, 54 x 250 ft., adjoining; a complete paper drying department will be installed, as well as power plant for factory operation. The complete plant is estimated to cost in excess of \$200,000. Albert F. H. Seelig, 2194 Railroad Exchange Bldg., St. Louis, is engineer. E. B. Fish is president.

#### New Jersey

MATAWAN—The Mosaic Tile Co. has awarded a contract to Walter V. Patton, 273 Main St., for the erection of two 1-story additions to its plant, 60 x 138 ft. and 27 x 182 ft., respectively, for increased production. Work will be commenced at once, and it is proposed to have the buildings ready for machinery at an early date. Headquarters of the company are at Zanesville, O., and Walter Miller, regularly located there, will supervise the construction and equipment installation.

LAMBERTVILLE—The Lambertville Pottery Co., manufacturer of sanitary ware, has commenced the construction of a new kiln at its plant.

LAMBERTVILLE—The Perseverance Paper Mill Co. will make a number of improvements in its local mill, prior to a resumption of production during the coming months. New equipment will be installed in different departments, and present machinery repaired and overhauled. It is planned to remodel certain portions of the mill.

#### New York

NEW YORK—The Robinson Stoneware Co., 226-36 Newell St., has filed plans for the rebuilding of the portion of its plant recently destroyed by fire. The work is estimated to cost about \$20,000.

ALBANY—The Hires Turner Glass Co., Philadelphia, has completed the erection of its branch plant on Tivoli St., near Broadway, and operations have been commenced. A manufacturing department will be maintained for the production of mirrors, beveled window glass, etc.

#### Ohio

EAST PALESTINE—The National Fire-proofing Co., Fulton Bldg., Pittsburgh, Pa., will rebuild by day labor its plant at East Palestine, recently destroyed by fire, and excavations for the main building, 100 x 100 ft., are under way. The work will cost about \$60,000. Sidney F. Heckert, Besemer Bldg., Pittsburgh, is architect.

CLEVELAND—The Carbo-Oxygen Co. has construction under way on an addition to its local plant, devoted to the manufacture of carbo-hydrogen gas, for the manufacture of oxygen gas. Similar additions will be erected, also, at the company plants at Columbus, O.; Bayonne, N. J.; Coraopolis, Pa.; and Chicago, Ill., and initial work has been commenced. At Buffalo, N. Y., work is proceeding on a new plant for the manufacture of carbo-hydrogen gas and oxygen gas. To carry out the details of the expansion, the company has arranged for a preferred stock issue of \$2,000,000. J. C. Trees, Pittsburgh, Pa., is president.

#### Oklahoma

DEWEY—The Dewey Portland Cement Co., Mutual Bldg., Kansas City, Mo., has awarded a contract to the MacDonald Engineering Co., 53 West Jackson Boulevard, Chicago, Ill., for the erection of an addition to its plant at Dewey, estimated to cost about \$60,000. Work will be commenced at an early date.

TULSA—The Producers & Refiners Corp. is perfecting plans for the erection of a wax lubricating and grease plant at its oil refinery at West Tulsa.

#### Pennsylvania

PHILADELPHIA—Fire, Nov. 18, destroyed a portion of the lamp black and carbon manufacturing plant of the L. Martin Co., Raleigh St., with loss estimated at about \$100,000, including equipment. It is said that the plant will be rebuilt.

PITTSBURGH—The Birmingham Mirror Co., 2014 Josephine St., manufacturer of mirrors and other glass specialties, has tentative plans under consideration for enlargements in its plant.

PHILADELPHIA—The United Oxygen & Mfg. Co., Bath and Westmoreland Sts., has filed plans for the erection of a 1-story plant.

#### Tennessee

KNOXVILLE—The Knoxville Glass Co. has arranged for the construction of a 1-story plant, 90 x 100 ft., for the manufacture of mirrors and other glass products.

#### Texas

BEAUMONT—The Humphreys-Pure Oil Co., Dallas, is planning for the construction of a new refinery at Beaumont. The local Chamber of Commerce is interested in the project. Paul Gage will be in charge of the erection. A. E. Humphreys is president.

McGREGOR—The Koury Calcium Co., recently organized with a capital of \$400,000, has acquired property near McGregor, totaling about 150 acres of land, as a site for the erection of a plant for the manufacture of lime products. The proposed works will have a capacity of about 1,000 bbl. of finished material a day, and are estimated to cost close to \$100,000, including machinery. Michael Koury is president of the company, and W. V. Hanover secretary.

CAMERON—The Owens Refinery Co., Ardmore, Okla., is perfecting plans for the immediate erection of a local oil-refining plant, with initial output of about 1,500 bbl. a day. Local offices will be established in the First National Bank Bldg.

#### Utah

SALT LAKE CITY—The Industrial Potash Corp. is perfecting plans for the erection of a new mill, estimated to cost close to \$1,500,000, including machinery. A bond issue for this amount has been arranged to carry out the details of the project.

#### Washington

SEATTLE—The Commonwealth Finance Co., Securities Bldg., is arranging details for the formation of a new company, which will build a local plant for the manufacture of soap products. The company will be capitalized at \$250,000 and headed by C. H. Colson. Negotiations are under way for a lease of property on Westlake Ave., as a site for the new factory.

#### Wisconsin

MILWAUKEE—The Wadham Oil Co., 359 Clinton St., has construction under way on a new oil refinery at Thirty-third and Burnham Sts., estimated to cost about \$100,000, with equipment. S. S. Cramer is president.

## New Companies

**THE SCANLON LEATHER CO.**, Boston, Mass., has been incorporated with a capital of \$25,000, to manufacture leather products. J. Frank Scanlon, 233 Purchase St., is president; and George Strangman, Swampscoot, Mass., treasurer.

**E. F. DREW & CO., INC.**, New York, has been incorporated with a capital of \$50,000, to manufacture chemicals and chemical byproducts. The incorporators are T. P. Durrell, R. Dadd and C. S. Soule. The company is represented by Hun, Parker & Reilly, Albany.

**THE GREENBERG BOTTLE CO.**, Newark, N. J., has been incorporated with a capital of \$100,000, to manufacture bottles and other glass products. The incorporators are Samuel B. Ferster, Wesley B. King and Herman W. Brams, 800 Broad St., Newark.

**THE PLANT, THEIS & GOULD PAPER CO.**, 30 North La Salle St., Chicago, Ill., has been incorporated with a capital of \$50,000, to manufacture paper products. The incorporators are William M. Plant, Robert S. Theis and George W. Gould.

**THE SILVER LEAF PETROLEUM CO.**, Fort Worth, Tex., has been incorporated with a capital of \$250,000, under Delaware laws, to manufacture petroleum products. The incorporators are J. P. Haley and C. L. Barfield, Fort Worth; and G. E. Wilson, Mineral Wells, Tex. The company is represented by the United States Corporation Co., 65 Cedar St., New York.

**THE GOLDEN STATE COLOR & CHEMICAL WORKS, INC.**, Long Beach, Cal., has been incorporated with a capital of \$25,000, to manufacture chemicals, colors and affiliated products. The incorporators are J. S. Reardon, R. L. Buffum and J. V. Nevin, Long Beach.

**THE LAGLER PAPER PRODUCTS CO., INC.**, New York, has been incorporated with a capital of \$40,000, to manufacture paper goods. The incorporators are D. R. Daly, O. Wuest and H. G. Smith. The company is represented by York & York, 7 Dey St.

**THE HOLLAND GLASS WORKS, INC.**, 615 West Monroe St., Chicago, Ill., has been incorporated with a capital of \$40,000, to manufacture brass and bronze products. The incorporators are Frank J. and F. B. Liska.

**THE LINCOLN OIL CO.**, Wilmington, Del., has been incorporated under state laws with capital of \$2,000,000, to manufacture refined oil products. The company is represented by the Delaware Registration Trust Co., 900 Market St.

**THE CHARLES F. MARTIN LUBRICATING CO.**, Tulsa, Okla., has been incorporated with a capital of \$10,000, to manufacture lubricating oils, greases, etc. The incorporators are D. D. and Charles F. Martin, and A. F. Hoffman, Jr., all of Tulsa.

**THE TWIN CITY LEATHER CO.**, Gloversville, N. Y., has been incorporated with a capital of \$40,000, to manufacture leather products. The incorporators are F. W. and M. Shire, and B. W. Drauns, Gloversville. The company is represented by T. Haviland, Gloversville.

**THE TITAN STEEL TUBE CO.**, 4851 North Springfield Ave., Chicago, Ill., has been incorporated with a capital of 2,500 shares of stock, no par value, to manufacture steel tubing. The incorporators are William Smith and Martin Swanson.

**THE PORCELAIN APPLIANCE CORP.**, Parkersburg, W. Va., has been incorporated with a capital of \$25,000, to manufacture porcelain specialties, including electrical porcelain products. The incorporators are J. H. Parker, Parkersburg; H. R. Holmes, East Liverpool, O.; and R. G. Spencer, Carey, O. The company is represented by the Corporation Trust Co. of America, du Pont Bldg., Wilmington, Del.

**THE PEARL OIL CO.**, Jamestown, N. Y., has been incorporated with a capital of \$100,000, to manufacture refined oil products. The incorporators are P. W. Goodwin, E. W. Olson and C. O. Johnson. The company is represented by J. R. Rogerson, 136 Bartlett Ave., Jamestown.

**THE SOLIDONE MFG. CO.**, Newark, N. J., has been incorporated with a capital of \$125,000, to manufacture chemicals and chemical byproducts. The incorporators are I. S. Fleitell, Charles Schaetzle and Simon W. Gordon, 183 Lillie St., Newark.

**THE TARX CHEMICAL CO.**, 348 East Illinois St., Chicago, Ill., has been incorporated with a capital of \$25,000, to manufacture chemicals and chemical byproducts. The incorporators are L. E. Harding, W. C. Waggoner and W. S. Carson.

**THE BULLION CHEMICAL CO.**, Memphis, Tenn., has been incorporated with a capital of \$50,000, to manufacture chemicals and chemical byproducts. The incorporators are Howard Brode and Isadore Bullion, both of Memphis.

**THE W. E. FRANKS OIL CO.**, New York, has been incorporated with a capital of \$105,000, to manufacture refined oil products. The incorporators are F. Anderson, I. Randall and W. E. Franks, New York. The company is represented by W. J. Kenny, New Brighton, S. I.

**CHENT & CO., INC.**, New York, has been incorporated under Delaware laws with capital of \$500,000, to manufacture magnesium cements and other plastic materials. The company is represented by the United States Corporation Co., 65 Cedar St., New York.

**THE OWENS & TRAEGER CARTON CO.**, Hoboken, N. J., has been incorporated with a capital of \$200,000, to manufacture folding paper boxes and cartons, and other paper specialties. The incorporators are Frank E. Kolb, Christopher W. Traeger and Clarence M. Owens, 1100 Adams St., Hoboken.

**THE FRANCE-UTAH OIL CO.**, Salt Lake City, Utah, has been incorporated under Delaware laws with capital of \$5,000,000, to manufacture refined petroleum products. The incorporators are J. W. Musser and D. H. Gustavesen, Salt Lake City. The company is represented by the Corporation Service Co., Wilmington, Del.

## Industrial Notes

**THE ESSENTIAL OIL SPECIALTIES CO.**, Philadelphia, Pa., has changed its name to the Essential Oil Co., and moved its offices to Mulberry and New York Ave., Trenton, N. J.

**THE AETNA EXPLOSIVES CO.** has been succeeded by the Hercules Powder Co. The advertising, purchasing and traffic departments are at Wilmington, Del., and the branch sales office is at 120 Broadway, New York City.

**THE RAYMOND BROS. IMPACT PULVERIZER CO.**, Chicago, Ill., has located a permanent Eastern office at 50 Church St., New York City. S. B. Kanowitz will be in charge.

**THE POWDERED COAL ENGINEERING & EQUIPMENT CO.** moved its offices and manufacturing plant from Chicago to Buffalo, N. Y., on Nov. 1. The personnel of the organization has been somewhat changed and H. B. Pruden has been elected as chairman of the board and J. W. Lansing of Buffalo has been elected president. The new board of directors of the company is as follows: J. W. Lansing, Fenton M. Parke, J. E. Finley, Harry R. Wait, J. C. Trefts, H. B. Pruden, B. W. Wistar, W. M. Faber and Stephen T. Lockwood.

**THE POWDERED COAL DEVELOPMENT CORP.** has been organized, with headquarters at Omaha, Neb. This company controls the Pruden patents for the burning of pulverized coal in the western half of the United States. The company is actively engaged in financing and erecting central pulverizing plants and installation of equipment for burning pulverized coal. Byron B. Oberst, formerly with the Interstate Oil & Refining Co., is president of the new corporation. The board of directors includes R. M. Robertson, construction engineer, American Smelting & Refining Co.; A. E. Hall, manager Omaha plant, American Smelting & Refining Co.; Joseph C. Weeth, president of the Harmon Weeth Coal Co.; J. J. Dodds, president of the Dodds Lumber Co.; Bert Phillips, formerly chief engineer, Collis Products Co., Omaha plant, and Irving H. Arey, with the Republic Metal Ware Co.

**THE HARDINGE CO.**, New York, announces that H. A. Kimber, formerly of the Quigley Furnace Specialties Co., is now in charge of the sales of the Quigley pulverized fuel department of the Hardinge Co., in New York, N. Y. L. W. Marso, who is in charge of the branch office of the Quigley Furnace Specialties Co., located at 427 Oliver Bldg., Pittsburgh, Pa., will continue in the Pittsburgh office under the name of the Hardinge Co., but will specialize in the handling of the Quigley pulverized fuel systems, which department has been acquired by the Hardinge Co. from the Quigley Furnace Specialties Co.; O. M. Rau, formerly consulting engineer to the Philadelphia Rapid Transit Co., has become associated with the Hardinge Co., and will specialize in the handling of Quigley pulverized fuel systems as applied to boilers. W. O. Renkin has become associated with the Hardinge Co., New York, N. Y., in the capacity of managing engineer of the Quigley pulverized fuel department.

**THE UNITED STATES CAST IRON PIPE & FOUNDRY CO.**, Burlington, N. J., announces the opening of a new office at 811 Dixie Terminal Bldg., Cincinnati, O. P. T. Laws, assistant works manager, will make this point his headquarters. Sales from this office will be in charge of Harold G. Henderson.

## Capital Increases, Etc.

**THE SUPREME PAPER BOX CO.**, 10 Forest St., Brooklyn, N. Y., has filed notice of increase in capital from \$25,000 to \$50,000.

**THE POWERS-WEIGHTMAN-ROSENTHAL CO.**, 916 Parrish St., Philadelphia, Pa., manufacturer of chemicals, has filed notice of decrease in capital stock from \$3,390,000 to \$1,700,000.

Reorganization plans are being perfected by officials of the REPUBLIC RUBBER CO., Youngstown, O. A change in capitalization and stock issues will be made.

**THE R. L. GREENE PAPER CO.**, Providence, R. I., has filed notice of increase in capital from \$50,000 to \$500,000.

**THE OIL PRODUCTION CO.**, Houston, Tex., has filed notice of increase in capital from \$55,000 to \$75,000.

**THE GOODRICH TIRE & RUBBER CO.**, Akron, O., has disposed of a bond issue of \$27,500,000, the proceeds to be used for general operations, expansion, etc. E. G. Wilmer is president.

**THE W. R. HOLLINGSHEAD CHEMICAL CO.**, a Delaware corporation, has filed notice of intention to operate in New York, with capital of \$1,000,000, for the manufacture of chemical products, with headquarters at Binghamton. W. R. Hollingshead and C. M. Reynolds, Binghamton, represent the company.

**THE TOWNS PAINT CO.**, 222 Pearl St., Buffalo, N. Y., has filed notice of increase in capital from \$100,000 to \$200,000.

Officials of the NATIONAL LEATHER CO., 161 South St., Boston, Mass., are arranging reorganization plans for the company, to include a preferred stock issue of \$15,000,000. The common stock will be reduced from 3,000,000 to 750,000 shares.

## Coming Meetings and Events

**AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE** will hold its seventy-fourth meeting at Toronto, Canada, Dec. 26 to 31, 1921.

**AMERICAN CERAMIC SOCIETY** will hold its twenty-fourth annual meeting at St. Louis, Feb. 27 to March 2, 1922.

**AMERICAN CHEMICAL SOCIETY** will hold its spring meeting at Birmingham, Ala., April 4 to 7, 1922.

**AMERICAN ENGINEERING COUNCIL** will hold its next meeting in Washington, Jan. 5-6.

**AMERICAN FOUNDRYMEN'S ASSOCIATION** will hold its next convention and exhibit at Cleveland, O., during the week of April 24, 1922. Meetings will be held in the spring instead of in the fall as heretofore.

**AMERICAN INSTITUTE OF CHEMICAL ENGINEERS** is holding its annual winter meeting at Baltimore, Md., Dec. 6 to 9. Headquarters are at the Emerson Hotel.

**AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS** will hold its spring meeting in New York the week of Feb. 20, 1922.

**AMERICAN PETROLEUM INSTITUTE** is holding its second annual meeting at the Congress Hotel, Chicago, Dec. 6, 7 and 8.

**NEW JERSEY CHEMICAL SOCIETY** holds a meeting at Stettner Restaurant, 848 Broad St., Newark, N. J., the second Monday of every month.

**STAMFORD CHEMICAL SOCIETY**, Stamford, Conn., holds a meeting in the lecture room of the local high school on the fourth Monday of each month, except June, July, August and September.

The following meetings are scheduled to be held in Rumford Hall, the Chemists' Club, New York: Dec. 9—American Chemical Society, regular meeting. Jan. 6—American Chemical Society, regular meeting; Jan. 13—Society of Chemical Industry, Perkin Medal; Feb. 10—American Electrochemical Society (in charge), Society of Chemical Industry, Société de Chimie Industrielle, American Chemical Society, joint meeting; March 10—American Chemical Society, Nichols Medal; March 24—Society of Chemical Industry, regular meeting; April 21—Society of Chemical Industry (in charge), American Electrochemical Society, Société de Chimie Industrielle, American Chemical Society, joint meeting; May 5—American Chemical Society, regular meeting; May 12—Société de Chimie Industrielle (in charge), American Chemical Society, Society of Chemical Industry, American Electrochemical Society, joint meeting; May 19—Society of Chemical Industry, regular meeting; June 9—American Chemical Society, regular meeting.